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Evaluating the effectiveness of micro-hydropower projects in Nepal

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EVALUATING THE EFFECTIVENESS OF MICRO-HYDROPOWER PROJECTS IN NEPAL

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ABSTRACT

EVALUATING THE EFFECTIVENESS OF MICRO-HYDROPOWER PROJECTS IN NEPAL

by Shradha Upadhayay

Nepal is one of the world's poorest countries. One of its most pressing environmental concerns is its need for stable, community-managed power. Because extending the Nepalese national power grid would be expensive and problematic, micro-hydro projects have proven to be an economical and efficient alternative in the effort to power remote villages deep in the mountains. However, the efficiency of many of these projects is debatable. This study investigates the efficacy of community-based micro-hydro projects in two remote villages, Luwang Ghalel and Ghandruk, as well as the role of public participation in these projects.

This report employs a case study methodology, with data collection taking the form of interviews, surveys, and document reviews. The results of this study show that micro-hydro projects are a temporary solution at best. Based on internationally accepted criteria, both the technical performance and the level of public participation at both projects were found to be very low. Gender, caste, ethnic group, and socio-economic stratification have also seen an unequal distribution of the project benefits. Our findings indicate that both the Nepalese government and associated non-governmental organizations must make significant policy changes if they hope to achieve success in future development work with community-based micro-hydro projects.

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I dedicate this work to my husband Roshan for his moral support and bottomless inspiration during my graduate program.

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Acronyms

ACAP	Annapurna Conservation Area Project
ADB	Agriculture Development Bank
AEPC	Alternative Energy Promotion Center
AKRSP	Aga Khan Rural Support Program
BODF	British Overseas Development Fund
DCRDC	Dhaulagiri Community Resource Development Center
ESAP	Energy Sector Assistance Program
ICIMOD	International Center for Integrated Mountain Development
INGO	International Non-Governmental Organization
ISO	International Standard Organizations
ITDG	Intermediate Technology Development Group
kW	Kilowatt
MCDM	Multi Criterion Decision-making
MHP	Micro-hydro project
MW	Megawatt
NEA	Nepal Electricity Authority
NGO	Non-Governmental Organization
PCAT	Pakistan Council of Appropriate Technology
REDP	Rural Energy Development Program

UNDP-GEF	United Nations Development Program-Global Environment Facility
VDC	Village Development Committee
W	watt

Introduction

Nepal is a nation rich in water, with copious precipitation flowing from the Himalayas at an elevation of 3500 m or higher (Panthi & Nilsen, 2007). According to estimates from Rural Energy (2007), Nepal has the potential to generate 40,000 MW from large-scale hydropower and 50 MW from micro-hydro plants, but to date, facilities producing only about 533 MW (527 MW from large-scale and 6 MW from small-scale hydro projects) have been developed. While Nepal designates electricity shortages a national emergency, according to the NEA, 80% of the Nepalese population remains without electricity.

According to the Nepal News (2009), power outages are in effect 15 to 18 hours per day. In 2007, the Nepal Electricity Authority (NEA) was unable to meet the total energy demand of 23% during the day and 41% at night. At present, the evening electricity demand in Nepal is 720 MW, of which the NEA is able to provide a paltry 360 MW. The excess demand is met by India, which exports 60 MW to Nepal. Load shedding brings in the remaining 300 MW. The NEA cites lack of additional power development as the main reason for this energy crisis (NEA, 2008).

The NEA is unable to expand its grid-based electricity system because of technical, environmental, and most importantly, financial constraints (Billinton & Pandey, 1999). The country's mountainous terrain and complex geology alone make the extension of grid-based electricity nearly impossible (Panthi & Nilsen, 2007). The cost

of grid extension averages $10,000-$30,000 (Tanwar, 2007) in such terrain, is far too costly for the NEA. A NEA-proposed solution to the energy crisis concerns the construction of micro-hydro projects.

Used for power generation up to 100 kW, micro-hydro projects have gained enormous popularity in developing countries during the last four decades (Khennas & Barnett, 2000). Micro-hydro generation is a cost-effective and low-impact technique for power generation that offers a potential solution for rural electrification in Nepal (Paish, 2002). According to a 2005 report by the Alternative Energy Promotion Centre (AEPC), 1,956 micro-hydro schemes with an overall capacity of 13,064 kW have been installed since 1962.

There is much scholarly documentation of the technical success of community-based micro-hydro projects in the literature (Mallandu Development Society, 1999; Edwards, 1986; Holland, 1983; Osti, 2002; Khennas and Barnett, 2000; Rural Energy, 2007). Unfortunately, there are few, if any, related studies that provide a detailed evaluation of the role that public participation plays in these micro-hydro projects. This study aims to perform such an examination, concentrating on two micro-hydro projects in the Nepalese villages of Ghandruk and Luwang Ghalel.

Literature Review

Micro-hydro is a term used to describe electricity-producing installations of up to 100 kW. This technology falls into one of three categories: Peltric, Non-Peltric, or Improved Ghattas. Peltric sets are small, vertically-mounted units with impulse-type turbines and induction-type generators, and usually produce less than 5 kW. Non-Peltric sets use Pelton or cross-flow turbines and typically produce more than 5 kW. Improved Ghattas use a traditional water wheel but instead of wood, the wheel is steel. This difference offers significant increases in productivity. Improved Ghattas are used exclusively for grinding and de-husking and do not produce electricity (Alternative Energy, 2005). Figure 1 illustrates two types of Non-Peltric generators commonly used in Nepal.

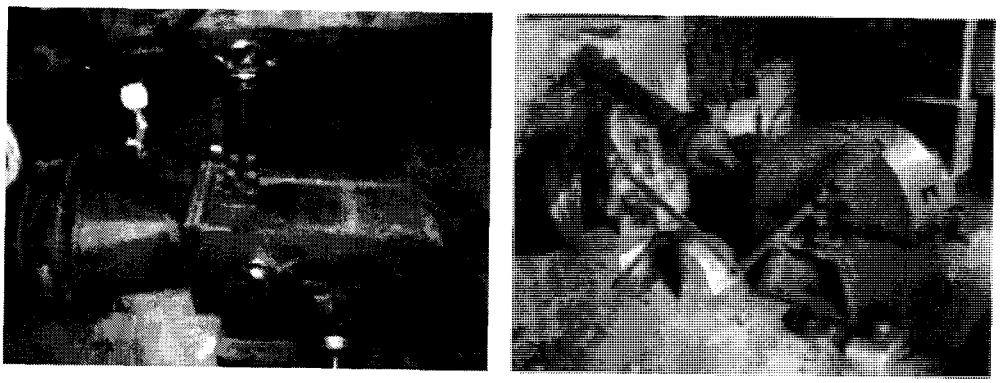

Figure 1. Luwang Ghalel and Ghandruk Non-Peltric Sets (Photo by author)

Micro-hydro power projects (see Figure 2) typically include a water intake, a weir or dam, penstock pipes, a turbine and a powerhouse. Water flowing from a source, typically a river, is directed into the intake, which screens fish or other debris from entering the turbine. After passing through the intake, water flows to the penstock pipe, which carries the water to the turbines inside the powerhouse. The water rotates the turbines, which drives the generators that produce electricity. This electricity is then transmitted to houses through transformers and transmission lines (Alternative Energy, 2005).

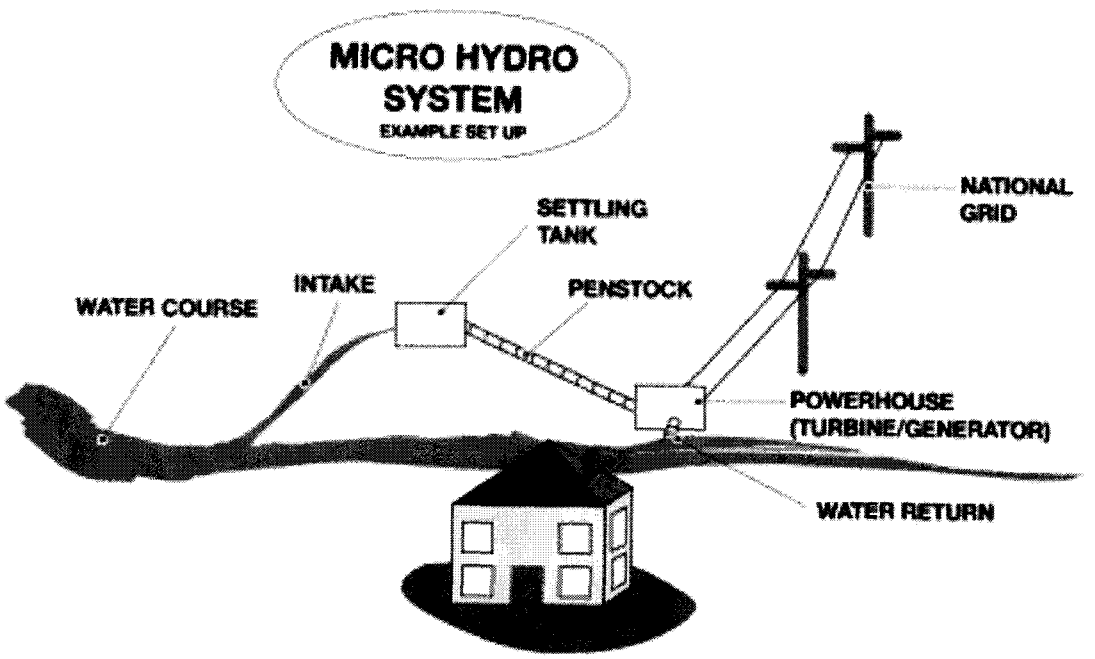

Figure 2. System of Micro-hydro Power Projects (© 2009 Rain Wind and Sun. Used with permission)

There are currently 1,956 micro-hydro schemes in Nepal, of which 810 are Peltric, and 347 are Non-Peltric. The installation of these systems are installed and overseen by local entrepreneurs, Non-Governmental Organizations (NGOs), local manufacturers, International Non-Governmental Organizations (INGOs) and the United Nations Development Program-Global Environment Facility (UNDP-GEF) (Rijal, 2000). The Nepalese government has taken a number of initiatives that they hope will foster the development of these projects. A license is not required to install a micro-hydro project as long as it produces 1000 kW or less. In addition, the government established the AEPC to promote renewable energy within the country. In addition, to help foster the development of micro-hydro projects, Nepal joined the United Nations Development Program-Rural Energy Development Program (UNDP-REDP). This relationship has encouraged INGOs to support these installations through providing capital subsidies and building greater capacity. Nepal administers its subsidy program through the national Agricultural Development Bank (ADB) (Alternative Energy, 2005).

Related Research

Rural areas rich in water resources regard community-based micro-hydro projects as among the best sources of renewable energy. In their study, Burton & Holland (1983), detailed how a rural village in Columbia was able to set up a communal sawmill and used the surplus generated power for domestic purposes, thereby involving the whole community in the process. The authors point out that this community's biggest

motivation for involvement was the need to raise the quality of their children's lives. The key factors that contributed to the success of this program's success were the aid provided by a regional rural NGO, the community collaboration with civil work design, and villagers' labor contribution toward the construction of the project. This type of widespread involvement kept the cost for providing power very low.

In a similar study (Edwards, 1986) of communities in the Peruvian Sierra, a local man designed and installed a micro-hydro system, and won support from community leaders and a regional NGO. The project was so successful that the Peruvian government is now hoping to install similar systems in the surrounding communities. This is a pressing concern, as so far, electricity reaches only 19% of rural Peru. Expansion of micro-hydro systems will help solve this lack of access.

Micro-hydro projects are community-based and are owned and operated by local villagers. According to (Khennas & Barnett, 2000, p.35), "A major theme in the development of micro-hydro technology has been the huge effort put forth in "Participative Approaches" to create, nurture and capacitate communities to build, own and operate micro-hydro plants." This theme has resonated throughout countries that now employ community-based micro-hydro projects. In Pakistan, the Aga Khan Rural Support Programme (AKRSP) has established 28 micro-hydro plants for research.

A micro-hydro project implemented by the Mallanadu Development Society (NGO), in the village of Thulappaly in the western Indian state of Kerala, has also been successful with regard to its environmental benefits, capacity development, reduced

community drudgery, and improved opportunities for education. For this project, community involvement was the main factor that led to success, with the local residents feeling a high degree of ownership toward the project. Smith (1994) suggests that since sites are often picked by survey engineers, operating solely from economic and technical feasibility viewpoints, community involvement with site selection is helpful to best reflect the needs and wants of the people that will be most directly impacted by the results of the project.

Not all of the literature on micro-hydro project as a development tool is positive. Rijal (2000) argues that community-based plants are ideal in theory, but do not seem to work as well in practice as privately-owned plants. Although community participation allows many to contribute labor and raises the status-quo of a village, the financial cost involved can prove prohibitive (Khennas & Barnett, 2000). Sinclair (2003) argues that there are gaps in the goals and objectives of these projects with respect to the community.

Furthermore, distribution of electricity is unfair. Access to generated power can be limited through social stratification along gender, caste, and ethnic lines, as well as socio-economic status (Gupte, 2003). The caste system plays an important role in Nepal. Those in the lower castes do not receive the same services provided to others (Stash & Hannum, 2001). As discussed below, these projects suffer from social/managerial, technical, and financial constraints.

Social and Managerial Problems. Project managers often fail to understand the communities they are working with, especially from a social standpoint. According to

Maginn (2007), "Policymakers often set up local partnerships with insufficient knowledge of the 'culture' g (i.e., structure, processes, practices, relations, and agents) of the neighborhoods and communities they seek to regenerate, and involve in decision-making." Gupte (2003) identified that women are those most directly impacted by hydro project installation, but are rarely present in the participatory process. Rural Energy (2007) reports, "Women have been identified as one of the most vulnerable groups and their empowerment has been highlighted as one of the six basic principles of REDP community mobilization process" (p.10). While the decision-making process does not formally exclude women, gender inequality is still rampant.

Khennas and Barnett (2000) explain that the form that the ownership of a micro-hydro project takes is a factor that does not make much difference. They do recommend that community-based micro-hydro projects adopt a concrete business management style, citing the importance of job training, the creation of by-laws, and the recording and filing of meeting minutes as critical to project success. Risal (2002) supports this view by recommending that private investors take the lead in managing hydro projects. In his work, he discovered plants installed by the Pakistan Council of Appropriate Technology (PCAT) to have high failure rates. Seventy four percent of these failures were due to managerial and social problems. Similarly, in a comparative study by Khennas and Barnett (2000), they found both Zimbabwe and Mozambique, in their efforts to develop effective renewable energy, have had greater financial success through privately-owned schemes than domestic use community-based micro-hydro projects.

Financial Problems. For a micro-hydro project to be financially successful, they must carry a high load factor (i.e., a project must fully utilize the produced energy). In most of the rural Nepalese villages, domestic lighting use provides the largest electricity demand, followed by television and radio. These amount to a low load factor. It is for this reason that it is essential to use micro-hydro power for income-generating activities to achieve long-term viability (Paish, 2002). For example, most of the work performed by micro-hydro projects in Nepal are mechanical in nature, such as milling and rice hauling (Paish, 2002).

In addition, for a community to be economically successful, it is often vital that they obtain outside funding. Due to a lack of knowledge and skills, this is not always possible. Most projects are dependent upon donors like the UNDP-GEF, NGOs, and high interest loans provided by the ADB (Osti 2002; Smith 1994; Risal 2002), which often discourage communities to establish a micro-hydro project. Due to social and economic hardships, communities often do not have the tools to alter their infrastructure. As management is often weak, the communities will suffer because they are unable to establish income-generating projects which would increase their load factor and, in turn, the long-term viability of the project.

Technical Problems. Micro-hydro projects often suffer due to a lack of trained individuals. As the ADB is responsible for funding, they will often only monitor the micro-hydro project from a financial perspective, with little incentive to enhance the technical capability of the village (Risal 2002; Smith 1994). Nepal manufactures and

repairs turbines locally, a practice which is cost-effective, but leads to turbines of low quality, adversely affecting the efficiency of many micro-hydro projects (Smith 1994).

Conceptual Framework for Understanding Public Participation

According to Saxena (1998),

> Participation is a voluntary process by which people, including the disadvantaged (based on income, gender, caste and education), influence or control the decisions that affect them. The essence of participation is having the ability to exercise voice and power of choice in order to develop human, organizational and management capacity to solve problems as they arise in order to sustain the improvements. (p.111)

Arnstein (1969) developed the Ladder of Participation, a diagram that expands on the bottom-up approach. She categorized citizen involvement into eight different levels, with "one" being the lowest level of participation and "eight" the highest. The first and second levels (just after "non-participation") are termed "Manipulation" and "Therapy." Examples of participation at these levels include those who participate in community meetings and other meetings by town planners. At these meetings, citizens feel involved and use their intellect to provide feedback, but their actual importance is low. To Arnstein, this participation is next to minimal because the actual decision-making happens at a higher level. Worse, this kind of participation is often a façade for policyholders who use braggadocio to show that they have involved the grassroots population in their overall decision-making process.

Beyond this token participation, Arnstein's third, fourth, and fifth levels are "Informing," "Consultation," and "Placation," respectively, or, taken as a whole, "Tokenism." These levels see an increased level of actual participation on the part of the community. The sixth, seventh, and eighth levels are grouped and designated "Partnership," "Delegated Power," and "Citizen Control," and as a whole are called "Citizen Power." These final three levels reflect actual power because the individual citizens are directly involved and have full control over the decision-making process.

Critics of Arnstein's ladder argue that his model is too simple and that it reflects a simplistic definition of participation. According to Maier (2001) citizen power should not be considered real participation because those involved may refuse to take leadership due to incapability or unwillingness. On the other hand, Wondeleck, Manring, & Crawfoot (1996) add three levels to the apex of Arnstein's ladder. Their first addition offers a choice in participation, the second allows citizens to participate effectively and the third offers the citizens a continued involvement of the process in order to capitalize on participation. Choguil (1996) criticizes Arnstein's ladder, arguing that it fits behavior paradigms seen in developed countries, but remains unsuitable for developing countries. Choguil suggests a new ladder of participation, grouping actions into four broader sections, and eight sub-sections. This model starts with "empowerment," followed by "partnership," "conciliation," "dissimulation," "diplomacy," "informing," "conspiracy," and "self-management." Also offering criticism, Tritter & McCallum (2006) argue that Arnstein's model is too linear and serves to undermine the potential for user involvement.

In addition, they claim that participation may be the only goal for some. By their estimate, Arnstein's ladder fails to address the methods and nature of user involvement.

Butterfoss (2006, p.331) suggests that community participation should be measured only based on the process (who, how, when, why, how many, how much of the community participates, and initiative) and program outcomes. She puts forth six measures, which serve as the conceptual framework for the evaluation of public participation. To fit the scope of this study, I modified these criteria to better fit the context of the micro-hydro project in Nepal. The Methods section will provide greater detail on operationalization of this framework, but in brief, I will be considering:

1. Opportunities and Levels of Decision-making
2. Degree of Local Ownership Perceived and/or Achieved
3. Satisfaction with the Process of Participation
4. Achievement in terms of Long-term Goals
5. Diversity of Participants (ethnicity, gender or age)
6. Benefits and Challenges of Participation

Conceptual Framework for Evaluation of Micro-hydro Projects

According to Powell (2006), "Evaluation research can be defined as a type of study that uses standard social research methods for evaluative purposes, as a specific research methodology, and as an assessment process that employs special techniques

unique to the evaluation of social programs" (p.102). The goal of this evaluation is to discover whether or not the studied programs performed effectively. Rossi, Freeman, & Lipsey (2004) propose five different criteria for program evaluation. These are "Needs Assessment," "Assessment of Program Theory," "Assessment of Program process," "Impact Assessment" and "Efficiency Assessment." The literature uses different evaluation approaches for various types of projects. Panti and Nilsen (2007) performed an evaluation study on four hydro projects in Nepal, attempting to assess the complex geological characteristics of the region. Similarly, Ozelkan & Duckstein (1996) have used Multi-Criterion Decision-making (MCDM) to analyze hydro-ecological management problems in the Danube region between Vienna, Austria and the Slovakian border. Tanwar (2007) performed an evaluative study on small-scale hydropower projects by judging their additionality. In addition, Masse (2002) evaluated the socio-economic situation of the forest tenant farming system in Quebec.

Although evaluation approaches differ from project to project, the selection of appropriate evaluative criteria remain a common theme among the aforementioned studies. All of these studies identified criteria before collecting and analyzing data. Adams & Ghaly (2007, p.443) used six different criteria and subcriteria (see Table 1) to best evaluate the sustainability of a project. Adams and Ghaly's criteria and subcriteria act as an initial framework for this study. In order to fit the scope of this study, I modified the framework during the operationalization process.

Table 1

Criteria for Program Evaluation (Adapted from Adams & Ghaly, 2007. Used with permission)

Criteria	Sub criteria
1. Economic Risk	Demonstrated technical success
	Percentage of available cash
	Available interest rates
2. Economic Return	Cost vs. gross revenue
	Payback period
3. Environmental Effects	Compliance with regulations
	Opportunities for internal/external integration of outputs
	Influence on other system chains (or external factors)
	Valuation of overall environmental protection
4. Cultural Acceptance	Level of technology transfer
	Management familiarity
5. Resource Efficiency	Overall increase in resource-use efficiency
	Dependence on operator skill
	Valuation of increased resource use
6. Social Stability	Opportunity for increased employment
	Influence on surrounding communities

Research Questions and Objectives

The literature focuses on community participation in hydro projects, offers little to explain the Who, How, When, Why, How many, and How much. There are no case studies that detail how participation increases project effectiveness, revealing a large gap between the relationship of hydro project goals and the respective community expectations for the project. Technical reports on micro-hydro projects are abundant, but those focusing on community participation are few.

This study investigates the effectiveness of community-based micro-hydro projects and the role of public participation in Luwang Ghalel and Ghandruk, two remote villages in Nepal. Specifically, this study answers the following questions:

1. What is the process of establishing a micro-hydro project in Nepal?

The objective of this research question is to explore the actors and document the process of establishing a micro-hydro project in Nepal.

2. How effective are community-based micro-hydro projects?

The objective of this research question is to evaluate the effectiveness of the micro-hydro project in meeting the electricity needs of the community.

3. What role does public participation play in program effectiveness?

The objective of this research question is to assess public participation at the village level and identify the relationship between program effectiveness and public participation.

Methods

Study Site

The two sites discussed in this research are Ghandruk and Luwang Ghalel Village Development Committees (VDC[1]) of Kaski district in the western region of Nepal. We chose Ghandruk and Luwang Ghalel as research sites because of their shared similarities with respect to five distinct criteria (see Table 2).

Table 2

Site Selection Criteria

Selection Criteria	Ghandruk VDC	Luwang Ghalel VDC
1. Topography	Mountainous terrain	Mountainous terrain
2. Power generation capacity	50 kW	44 kW
3. Size of population	4,748	4,758
4. Household Served	272	227
5. Ownership of project	Community	Community

Demographic information has been obtained from the Nepal Census 2001[2]. Ghandruk VDC has a total population of 4,748 or 1,013 households. The literacy rate of

[1] Politically, Nepal is divided into 14 zones, 75 districts and 5 Development Regions. Each district is split into a number of VDCs and Municipalities. Each VDC is further divided into 9 wards. Each Municipality is divided into a number of wards. (Ministry of Land reforms, Nepal)

[2] Hertel & Sprague (2007) suggest that census data is one of the most reliable sources not only because the information is free but also because regular updates occur every 10 years.

this VDC is 95% (46% males and 49% females). Economically, 76% of the population is working, though employed females (39%) rank slightly higher than males (37%). There is equal representation for both Hindus and Buddhists. According to the International Centre for Integrated Mountain Development (ICIMOD), "Indo-Aryan linguistic groups such as Kami, Sarki, Damai, Brahmin and Chetri tend to be Hindu while Tibeto-Burman communities like Gurung and Magar predominantly practice Buddhism." In Ghandruk, Gurungs constitute 62% of the total population, followed by Kamis (13%), Magars (6%), Sarkis (6%), Damais (5%), Brahmins (5%) and Chetris (5%) (Nepal Census, 2001). The Ghandruk micro-hydro project is the first of its kind in Nepal. This scheme generates 50 kW of power and provides electricity to 272 households (1,360 people) as well as to several lodges and a rice mill (Khennas and Barnett, 2000).

Luwang Ghalel VDC has a total population of 4,758 or 973 households. The total literacy rate of this VDC is 87% (39% for males and 48% for females). 73% of the total population works, though, similar to Ghandruk, females (39%) rank slightly higher than males (33%). Two ethnic groups comprise the majority of the population in this VDC: Hindus (76%) and Buddhists (25%). Gurungs constitute the majority of the population, though the literature does not provide a further breakdown on the remaining ethnic makeup of the population (Nepal Census 2001). Luwang Ghalel established its micro-hydro project in 2003, and their scheme generates 44 kW power and provides electricity to 227 households comprising a population of 1,135 (AEPC, 2007).

Figure 3. Map of Ghandruk and Luwang Ghalel VDC (© 2001 National Geographic Society. Used with permission).

Structure of the Study: Operationalization of Framework

Evaluation of the nature of public participation. In order to examine the role of public participation, this study applies criteria set by Butterfoss (2006) as framework. Table 3 outlines the operationalization of this conceptual framework, with indicators and tools for data collection, based on Butterfoss's criteria (2006).

Table 3

Operationalization of participation model (Adapted from Butterfoss 2007. Used with permission)

Criteria	Indicators	Tool
1. Opportunities and Levels of Decision-making	Participating but not voicing opinions Consulted/informed but not involved in decision-making Directly involved and have full control over decision-making	Semi-structured interview See Appendix A: PC (a)
2. Degree of Local Ownership Perceived	Level of participation in community meetings Providing financial/technical/social support	See Appendix A: PC (b)
3. Satisfaction with the Process of Participation	Recognition in community meetings Voice heard at meetings	See Appendix A: PC (c)
4. Diversity of Participants	Ethnic, social, gender and economic diversity	See Appendix A: PD (d)
5. Benefits and Challenges of Participation	Knowledge/Involvement in vital projects affecting the community Ability to make informed decisions Improved quality of life Difficulty in participation due to lack of self confidence and social barriers	See Appendix A: PC (e)

Evaluation of micro-hydro projects. This research uses a framework adapted from Adams and Ghaly (2007) to evaluate project effectiveness. Table 4 illustrates Adams and Ghaly's framework with attributes and tools for data collection.

Table 4

Operationalization of Adams and Ghaly's Evaluation Model

Criteria	Indicators	Tools
1. Adequacy of Funding	Total capital construction cost Percentage of loans and grant Tariff collection Operation and maintenance cost List of funders and donars	Appendix B (PP 1 to 13)
2. Technical Performance and project efficiency	Power output No. of households served Repair and maintenance Skill of operators and managers	
3. Technology Transfer	Replication of program to nearby villages	
4. Environmental Effects	Regulations associated with the micro-hydro project	
6. Social Stability	Increase in mills for grinding Satisfaction with the project	
7. User Satisfaction	No complaints about the system Reliable electricity for domestic and/or industrial use Improvement in education and health	Appendix A PU (7)

Overview of Data Collection

These two micro-hydro projects provide electricity to 272 and 227 households in Ghandruk and Luwang Ghalel VDC, respectively. According to the 2001 Nepal Census, there is an average of five people per household in both VDCs. The total population receiving service from the micro-hydro projects is 1,360 in Ghandruk VDC and 1,135 in Luwang Ghalel VDC. In order to best perform a quantitative study of these populations, with confidence level 95% and a confidence interval of 5%, 295 and 287 were the respective sample sizes we chose for Ghandruk and Luwang Ghalel VDC. This study utilized a semi-structured interview method as opposed to a survey, and it is because of this distinction that the recommended sample size was not relevant to this study.

Considering the resources available for fieldwork, I set the sample size at 30 semi-structured interviews, all asking open ended questions to 10 project promoters, and three focus group discussions in each VDC. I selected the participants through a stratified random sampling method, which proved useful as the population is divided into subgroups (Halliwell and Gold 1996). I chose gender and ethnicity as the two demographic variables to best stratify these participants, given that both factors play a significant role when discussing access to services or the lack thereof. This distinction is particularly important, as strict social stratification still exists in developing countries like Nepal (Gupte, 2003).

Two major ethnic groups comprise the population of both villages: Brahmin and Gurung. I scheduled 15 semi-structured interviews with each group. Gurungs represent

the majority while Brahmins, Chetris, and Dalits are in the minority. Accordingly, I conducted 15 semi-structured interviews within the Gurung community, while the remaining 15 were conducted with Brahmins, Chetris and Dalits. I conducted seven interviews with men and eight interviews with women. Table 5 provides additional details on the size and characteristics of our sample.

Table 5

Details on sample size

Groups	Methods	Number of Subjects (In both VDCs)
Project Promoters Government owned utilities Non-Governmental Organizations Equipment manufacturers Individual entrepreneurs	Key informant interview (Appendix B) Document review	N=10
Plant Owners/ Managers Utilities Municipal authorities Existing formal businesses such as Tea Estates Individual (village based) entrepreneurs Village or community groups	Key informant and semi structured interview (Appendix A and B)	N=10
Plant Consumers Residents (individuals, households) Commercial (hotels, tea estates, others) Non-profit (School, social organization)	Semi structured interview (Appendix A) Focus group	N=60

Once on-site, I identified dominant ethnic groups by area. To best randomize the interview order, I wrote the numbers one through ten on different slips of paper, with each representing a house where I had planned an interview. I then conducted interviews with either male or female members of the households. I used a snowball sampling method to conduct open/key-informant interviews at the organizational level. Following this method, I first identified key informants; then conducted subsequent interviews based upon information provided by these initial informants. I also conducted male, female, and mixed-gender focus group discussions in each VDC. Table 6 illustrates the respective stages of our research study.

Table 6

Stages of Research Study

Research stage	Methods	Tasks
Stage 1.	Literature review Familiarity with site Identify gatekeepers	Identify variables Research design
Stage 2.	Open-ended interviews Documentation review Observation	Analysis Identify new variables Identify sample size for next stage
Stage 3.	Semi-structured interviews Focus group discussions	Find linkages with RQs Identify new variables
Stage 4.	Data entry Data Analysis	Identify themes and patterns Statistical analysis

Results and Data Analysis

For data entry and quantitative data analysis, I made use of the Statistical Program for the Social Sciences (SPSS), using descriptive statistics to obtain the mean and standard deviation for all responses to close-ended and multiple-choice questions. For the qualitative analysis of our data, I used both open and focused coding. According to Bowen (2007) and Simon & Cleary (2005), coding allows the researcher to identify patterns, variations, and emerging themes within the data that may present links between related events, and present a way to move beyond mere description to more general dimensions of analysis.

In this study, criteria used for project evaluation and assessment of public participation served as preexisting themes. I designed interview questions to collect data as per the pre-existing criteria, which are presented in the next three chapters. Criterion such as sweat-equity emerged in the field, which we then added to the framework. For the first research question, I took a descriptive approach and documented the process of establishing a micro-hydro project. For the second research, I chose an analytical approach. I used sensitivity analysis[3] to analyze the data and tacked performance scores to the project based on the criteria against which they were evaluated. For the third research question, we documented the supportive quotes gleaned from interviews and

[3] An analysis used to determine how sensitive the results of a study or systematic review are to changes in process. Sensitivity analyses assess how robust the results are to uncertain decisions or assumptions about the data and the methods that were used.

identified themes and patterns. Then, I cross-tabulated our results from this program evaluation and the assessment of public participation in an attempt to examine the role of public participation in program effectiveness. During cross-tabulation, I identified emerging patterns that defined the relationship between our two dependent and independent variables.

Community-based Micro-hydro Projects Actors and Process

This chapter outlines the process and details the participants involved in creating a micro-hydro project in Nepal, a process that can be characterized by a simple community-based management systems. These systems allow for low costs, short construction periods, the utilization of aid from government loans and subsidies, and the involvement of both national and international donors. The main players involved in the creation of a micro-hydro project include the NGOs/INGOs that act as project promoters, as well as private and government-based institutions, project managers and other user groups.

Figure 4 outlines the actors and processes involved in the creation and operation of a micro-hydro project. The shaded area represents the steps where problems usually occurred during the process of establishing a micro-hydro project.

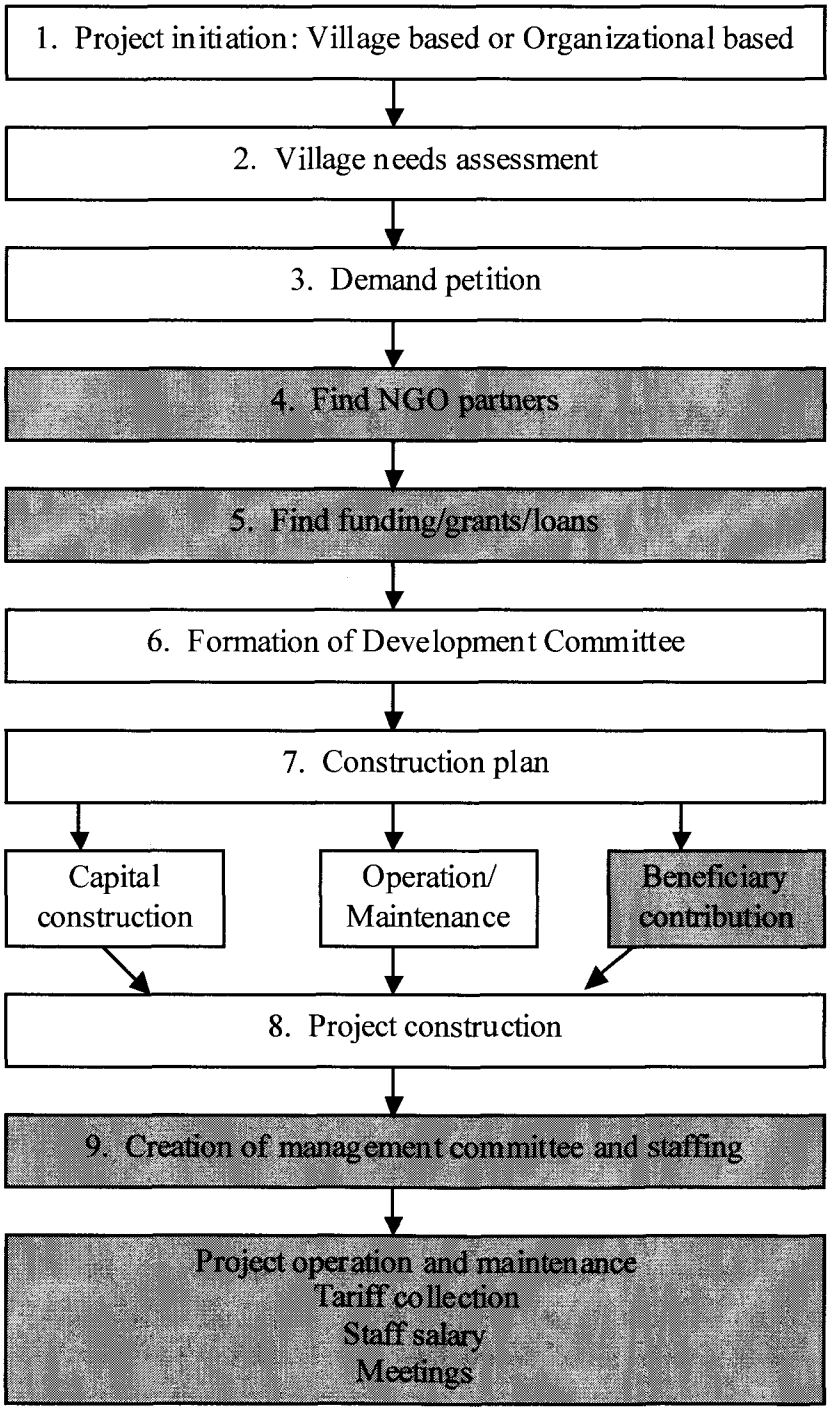

Figure 4. Process of establishing a micro-hydro project in Nepal

The first step in the project initiation process is exemplified in two ways, organization-based and village-based. In both instances the development, construction, and management responsibility of the project is the responsibility of the beneficiary community. In the organization-based process, NGOs and other groups with a history of working in a particular village will often initiate the micro-hydro project. The second and third step is to conduct a village needs assessment and create a demand petition. The organization will then collaborate with local villagers to produce a demand petition, a needs assessment report indicating the demand for electricity within the village. Once this is complete, the organization provides technical support and helps the villagers secure outside funding and other support.

The Annapurna Conservation Area Project (ACAP)[4] established the Ghandruk micro-hydro project. ACAP policy requires that the local community provide 15% of the funding for any micro-hydro project. An additional 80% is collected from donor agencies and the remaining 5% comes from ACAP's internal sources (ACAP policy on micro-hydro project, 2002).

By contrast, when using the village-based process, the community begins the project by independently creating a demand petition. The fourth step is to find NGO partner(s) that will support them through the construction process. Generally, when a

[4] Annapurna Conservation Area Project (ACAP) is the first and largest conservation area project in Nepal, covering 7,629 sq. km. Established in 1986 as an innovative concept for the protected area management system of the country, the conservation area embraces multiple land use principles of resource management that combine environmental protection with sustainable community development.

community opts to use this process, NGO partner(s) have already played an active role in the village and these organizations are acquainted with the welfare of the community.

The micro-hydro project in Luwang Ghalel uses a village-based approach. Responsible for bringing the project idea to the village was a man named Tek Bhadhur Shrestha, local villager and the ex-president of the Village Management Committee. He spoke of a young Nepali who had visited and shown him how to light his house by using a small turbine which ran with the aid of a water mill. As Shrestha put it, local villagers were "in awe" of this phenomenon and immediately demanded that electricity be brought into their homes as well. This fervor provided instant support for the micro-hydro project. A team of villagers got the ball rolling by making numerous trips to the district and head offices of AEPC/ESAP, ACAP in the Nepalese capital of Kathmandu to obtain information about what it would take to make the project a feasible reality (Personal interview, Ghandruk, 3 May 2006).

Once a demand petition is completed and a partnership with an NGO is established, the fifth step is to locate funding. Since most NGOs are familiar with beneficial local and international laws, they play a vital role in helping the village secure funding. The villagers of Luwang Ghalel chose DCRDC-Baglung[5] a non-governmental, non-profit local development organization, to help them with this process. Under its

[5]Dhaulagiri Community Resource Development Center (DCRDC) is a non governmental, non profit making local development organization established in 1995 by the self motivated local residents of Baglung to render basic social services to people focusing the poor, marginalized, and disadvantaged households living in rural areas of Baglung, Parbat, Myagdi, Mustang, and Kaski districts of the Western Development Region of Nepal. (DCRDC 2008)

Subsidy for Renewable Energy policy (2006), the Nepalese government provides a broad financial subsidy for the establishment of micro-hydro projects. Under this policy, the government agrees to provide the participating village with $1,101.36 per installed kW for new projects in the range of 5 to 500 kW. Both the projects in Ghandruk and in Luwang Ghalel were unable to utilize this grant program because they were established before the subsidy became available. Luwang Ghalel did find support on their micro-hydro project from the 1999 Energy Sector Assistance Program (ESAP) agreement between the governments of Nepal and Denmark, obtaining a budget of USD 28 million.

Once funding has been secured, the sixth, seventh, and eighth steps concern the formation of a volunteer-led development committee to supervise project construction, create a construction plan, and begin construction. There are no established rules for recruiting members to this committee; any active villagers who show an interest in the project may join. Social status can be an issue and those from affluent backgrounds are most often the volunteers. The Development Committee is responsible for overseeing all aspects of construction, including operation and maintenance, scheduling sweat equity, and monitoring monetary contributions from beneficiaries. The Development Committee is dissolved after the construction is complete.

The last step of the process concerns the establishment of a Management Committee. Some of the founding members may take a place on this committee, but this is also a point when new members may join the project. A typical Management Committee consists of eleven members, including a president, vice-president, secretary,

treasurer, and a body of general members. The major role of this committee is to act as a liaison between the beneficiaries and the project. The Management Committee will monitor tariff collection, allocate funds for village development activities, supervise and pay project staff, ensure a reliable electricity supply, and oversee the repair and maintenance of the project, including regulating the misuse of electricity, addressing complaints by the villagers, holding meetings for the consumer group, and presenting the financial budget to the entire village (Personal interview with Raju Dhahal, Operator of Luwang-Ghalel micro-hydro project, Luwang Ghalel, 10 May, 2008).

The Management Committees of both projects consist of a president, treasurers and general members, including volunteers as well as a paid staff. Members are usually voluntary and do not receive any kind of remuneration for their work on the project. This is the case in Ghandruk, but members of Luwang Ghalel micro-hydro project receive $1.20 per [6] meeting.

In both groups, committee members meet on a monthly basis, though emergency meetings can also be called when required. Meetings are held monthly in Ghandruk whereas in Luwang Ghalel meetings are annual. The members of these committees usually make the management and staffing decisions, and then notify the villagers.

Managers and Operators are employees, not volunteers. The size of the staff retained depends upon the scale of the project. In both of the micro-hydro projects that

[6]In Nepal, the average income per day is $1.10 for blue-collar workers and $1.81 for skilled laborers.

we studied, staffs consisted of one Program Manager and two Operators. The Manager was responsible for tariff collection, bookkeeping, extension of transmission lines, and supervision of Operators.

In Ghandruk, the Manager's salary is $58.93/month[7]. The same position in Luwang Ghalel, was originally $32.38/month but was soon set at $37.57/month (Personal interview of Ghandruk and Luwang Ghalel micro-hydro projects, 10 May 2008 and 10 June 2008). The Manager of the project in Ghandruk is an ex-army officer who was quite involved in the project, both physically and mentally. During our data collection, the entire pipeline, from source to village, collapsed due to a landslide. Acting heroically and tirelessly, the project's staff soon identified a new source of water, extending their existing pipelines and getting the powerhouse operational again within a week. In these efforts, the villagers did not have any engineering support from ACAP or other organizations. The villagers provided sweat equity to transport pipes by trekking them more than eight hours to the new source of water. In Luwang Ghalel, the manager is a woman and a member of the Development Committee.

The Operators oversee the day-to-day activities of the micro-hydro project, and are responsible for the repair and maintenance of all equipment. As the powerhouses provide electricity 24 hours a day, it is expected that the Operators monitoring the powerhouse in shifts to ensure that the system is running smoothly. Because afternoon

[7] All currency is in USD at the conversion rate of 1 USD= Nrs 77.2

load factor is low in Luwang Ghalel, the powerhouse shuts down for five hours during the day. Operators have worked on each project since they began operating.

In Ghandruk, both Operators have been in their positions for 17 years. They started at $19.43/month, but now receive a monthly salary of $58.29 each (Personal interview, Ghandruk, 15 may, 2008). Butwal Power Company provided them with initial training, which lasted one week and covered basic wiring, pipe connections, and water flow measurement. Both Operators have a fifth grade education but with 17 years of experience, they are able to perform most of the necessary repairs and maintenance on their equipment. If there is a problem with the generator, turbines, or control switch, they hire an outside expert. In general, as hiring an expert is expensive, the operators attempt to fix their mechanical problems locally.

In Luwang Ghalel, the Operators are considered to be either "junior" or "senior" based on their qualifications. The senior Operator joined the project with some experience though the junior Operator had none. The Senior Operator's salary is $54.40/month, while his junior associate is paid $50.52/month. (Personal interview, Luwang Ghalel, 10 June, 2008)

After obtaining proper staffing, transmission lines are built and extended to any household that has contributed labor and money to the project. Each household is required to pay for the wiring that connects the transmission line to their houses. In addition, each participating household must purchase a main switch and their own light bulbs, but the Development Committee pays for the pole and the major transmission

lines. Once construction is complete, the NGO provides basic training to the Operators and the Management Committee, and after this, the village assumes the day-to-day management of the project.

The construction and operating processes for both community-based micro-hydro projects studies were very well organized. The participants had a sense that they were contributing toward the sustainability and improvement of their respective villages and were fully committed to the progress of their projects. Micro-hydro power generation represents more than just a powerhouse and enhanced infrastructure, but also community improvement gained through group effects.

There were numerous problems in different steps of this process. The majority of the problems concerned finding NGO partners, obtaining funds/grants and loans, as well as contribution from beneficiaries, and the creation of management committees and proper staffing. These problems are highlighted in figure 4, and are discussed in detail in the following two chapters, Evaluation and Public Participation in micro-hydro project.

Evaluation of Community-based Micro-hydro Projects

This chapter evaluates the effectiveness of community-based micro-hydro projects based on our six research criteria, which are as follows: adequacy of funding, technical performance/project efficiency, cultural acceptance, social stability, user-satisfaction, and environmental effects.

General Project Information and Characteristics

The Ghandruk micro-hydro project generates 50 kW of electricity and runs nonstop. The total construction cost was $82,796, 35% of which was subsidized through grants from the British Overseas Development Canadian Fund (BODCF) and ACAP. Nepal's ADB provided loans covering 35% of the total cost. Villagers, through sweat equity and monetary contribution, contributed for the remaining 15%. Intermediate Technology Development Group (ITDG) collaborated with the Butwal Power Company to design and manufacture the necessary equipment for the project. At the outset of the project, the tariff rate was 0.8 cents/W, but it is now one cent/W for villagers and 1.29 cents/W for hotel owners. Tariff collection comes to approximately $550/month. The total operating cost per month is approximately $200 (Personal interview with villagers and committee members in Ghandruk, 20 May, 2008).

The Luwang Ghalel micro-hydro project generates 44 kW and runs 18 hours/day. The total construction cost was close to $110,491, 43% of which was covered by grants from AEPC-ESAP (DANIDA)[8] and the VDC and ACAP. The villagers compensated for the remaining 57% through sweat equity and monetary contribution. When the project began in Luwang Ghalel, the tariff rate was 1.3 cents/W. Since last year, this rate has decreased to 0.6 cents/W. Nepal's AC Power Company took the responsibility for the project's construction and installation. Table 7 displays the summary project information for both the Ghandruk and Luwang Ghalel projects.

[8]On March 26, 1999, the HMG/N and the Kingdom of Denmark signed an agreement to establish the Energy Sector Assistance Programme (ESAP) with a total budget of 154 million DKK. The ESAP is expected to run for 15-20 years. The Alternative Energy Promotion Centre (AEPC) and Nepal Electricity Authority (NEA) are the national agencies designated to help with the program. AEPC/ESAP promotes micro-hydro use by providing technical support through the mini grid support program (MGSP) for essential aspects of project development such as social mobilization project cycles and end-use. This micro-hydro component aims at continuing, increasing and sustaining the availability of electricity in areas through mini-grid projects in the near future. (AEPC 2006)

Table 7

Results from Luwang Ghalel and Ghandruk micro-hydro project

No	Criteria	Unit(s)	Luwang Ghalel (2003)	Ghandruk (1992)
1	Adequacy of funding	Total capital construction cost	$110,491.30[a]	$82,796.30[b]
		Loan (%)	None	35%
		Grant (%)	43%	50%
		Villagers' monetary contribution	57%	15%
		Village labor contribution per person per	150 days	3-4 days
		List of funders/donors /Banks	AEPC/ESAP, ACAP	ACAP, BODF, ADB
		List of NGOs working on the project	DCRDC	ACAP
		Operation/Maintenance cost per month	$200 /month	$200 /month
		Tariff for domestic use	0.8 cents/W/month	1 cents/W/month
		Tariff for commercial use	0.8 cents/W/month	1.29 cents/W/month
		Tariff collection per month	$352/month	$550/month
2	Technical performance and project efficiency	Power output (kW)	44	50
		Hours of usage per day	18 hours	24 hours
		No. of households served	243	272
		No. of times the project was shut down for repair and maintenance	1	3
		Total cost of repair and maintenance	$100	$14,815.30
		Skill of local operator	Trained on the job	Trained on the job

No	Criteria	Unit (s)	Luwang Ghalel (2003)	Ghandruk (1992)
2	Technical performance and project efficiency	No. of operators working	2	2
		Monthly salary of	$37.56/month	$58.93/month
		Monthly salary of operator	$50.51 /month $54.40/month	$58.29 /month
3	Technology transfer	No. of similar projects in nearby villages	1	6 <= 6 kW 1=100 kW
4	Social stability	% of villagers satisfied with management of the project	0	0
		% of mills increased after the project was established	Mill (stone cutting)	Hotels
5	User-satisfaction	% of villagers satisfied with management of the project	36.7%	40%
		% of villagers that feel the electricity provided by the project is reliable	70%	40%
		% of villagers that feel improved quality of life as a result of the project	50%	60%
6	Environment effects	List of rules and regulations for the project	None	ACAP policy

Note:

[a] Luwang Ghalel
Total project cost in 2003 (NRS): 7,470,466.283

Rate of exchange in 2003 of one USD = Rs. 79.113

Total project cost in 2003 in USD = $94,427.439

Inflation rate from 2003 to 2008 is 17%
Adjusted project cost in 2008 = $110,491.30

[b] Ghandruk
Total project cost in 1992 (NRS): 2,697,667.84

Rate of exchange in 1992 of one USD = Rs. 50

Total project cost in 1992 in USD = $53,953.356

Inflation rate from 1992 to 2008 is 53.5%
Adjusted project cost in 2008 = $82,796.30

We used the following steps to create an index and evaluate the performance of both micro-hydro projects: 1) Select success indicators; 2) assign weight to each indicator; 3) assign point values to projects for each indicator on a scale of 0 to 10; 4) sum up indicator point values to arrive at an overall performance score for each micro-hydro project; and 5) categorize micro-hydro projects according to their performance scores.

I selected twenty indicators based on the relevant data provided by the ITDG's final report on micro-hydro projects (2007), as well based on drawing from academic literature and experts in the micro-hydro field. Subsequent paragraphs will analyze and list the score of both projects under each criterion. Each criterion had a value range between 0 and 10, and sensitivity analysis provided an overall performance score for both projects.

Adequacy of Funding

To assess the financial success of a particular project, we analyzed them based on the following indicators:

- Costs contained by good design (Lifecycle costs/kWh)
- Survey of hydro potential and energy demand conducted
- Effective management of installations
- Collection of tariffs that keep pace with inflation

- Integration with other development projects
- Subsidies/Grants, focusing on increasing access through lowering initial costs rather than operating costs
- Adequacy, availability, skills and other functions of the project developer/ NGOs involved in the project during construction and management
- Amount of local capacity to manage, operate, and maintain micro hydro plants

Costs contained by good design. This factor was evaluated through calculating, for both projects, the lifecycle costs per kWh. The International Standards Organization (ISO) defines lifecycle costs as "the cost of an asset throughout its lifecycle while fulfilling the performance requirements." Over the first five years in both projects, the lifecycle costs per kWh micro-hydro projects are as follows:

The formula to calculate lifecycle costs per kWh is:
Lifecycle cost per kWh = [(construction cost + operation, repair and maintenance cost till date) - (tariff collected till date)] / [(kWh/yr)*no. of years]

Luwang Ghalel

Construction cost: $110,491.30

Operation and maintenance cost (2003 to 2008): $12,100

Tariff collected from 2003 to 2007 @ 1.3cents/W/month= $27,456[9]

Tariff collected from January 2008 to December 2008 @ 0.6 cents/W/month = $4,224

[9]For both projects, the "operation and maintenance cost" and "tariff collected" are approximate values. Neither project kept a logbook or performed proper accounting.

kWh/year = 44 kW x 18hrs x 365 = 289,080 kWh/year.

Lifecycle cost per kWh = [(110,491.30 + 12,100) - (31,680)] / [289,080*5]
= **0.628**

Ghandruk

Construction cost: $82,796.30

Operation, repair and maintenance cost (1992 to 1997): $6,000

Inflation rate from 1997 to 2008 is 34.1%: =$8,048.71

Domestic tariff collection (40 kW)

Tariff collected from 1992 to 1997 @ 0.8 cents/W = $19,200

Inflation rate from 1997 to 2008 is 34.1% = $25,755.87

Industrial tariff collection (10 kW)

Tariff collected from 1992 to 1997 @ 1.2cents/W = $7,200

kWh/year = 50kW x 24hrs x 365 = 438,000 kWh/year

Lifecycle cost per kWh = [(82,796.3+8,048.71) - (35,414.32)] / [438,000*5]

=**0.632**

The life-cycle costs per kWh of Luwang Ghalel and Ghandruk are 62.8 cents and 63.2 cents respectively. These similar lifetime cycle costs earned each project a performance score of eight.

Detailed survey and effective installations. In Ghandruk, prior to the project's establishment, the NGOs involved performed a detailed survey of hydro potential and energy demand. Despite this exhaustive study, there was little effective management during the project installation. During the testing process, a penstock pipe burst and the villagers had to replace it with an import from India. At this, ACAP announced that the

total cost of the project would rise by 10%. Still unpaid, this remains a significant setback for the project. The villagers argue that they were not at fault for this situation and should not incur this extra cost. Despite their protests, ACAP chose to add this price increase to the total project cost. The difficulty is seen when you consider how ACAP refuses to release additional funds until there is no remaining balance. Due to this argument, the villagers are losing monetary support for capacity building, as well as for any repair and maintenance (Personal interview with Satya Naryan Shah, ACAP and Purna Bhadhur Gurung, President of Ghandruk micro-hydro Management Committee, 22 May, 2008). Due to these factors, the project earned a performance score of ten—due to the detailed initial survey—but only earned a performance score of five for the effective installment of equipment.

In Luwang Ghalel, the AC Power Company is responsible for installation and design of the hydro project. Based on interviews with the village committee members, we have determined the construction cost quoted by the AC Power Company to be slightly higher than quotes from other builders. Because the work reached completion by the projected date, the village is satisfied with their performance. There have been no major problems within the last five years. It is for these reasons that this project has a performance score of 10, earned for both their detailed initial survey and their effective installation of equipment.

Collection of tariffs and integration with other developmental projects. The tariff rate in Ghandruk has increased over the duration of the project. Based on field

observation and document review, the serious funding problems for the Ghandruk micro-hydro project have been caused by outstanding capital loans, major repair and maintenance issues caused by catastrophic landslides, and management problems seen during the Maoist insurgency. Landslides have struck Ghandruk three times since the project has begun, and after each instance, the tariff on villagers was doubled to compensate for repairs and maintenance. Every time landslide issues had been resolved, the tariff was decreased to its standard rate, but the beneficiary community was forced to contribute additional hours of sweat equity. It is important to remember that the tariff increase does not follow a set trend and that an emergency is the only situation that warrants an increase in fees. If the tariff steadily increased over time, the project would not have faced these major financial setbacks. In Ghandruk, there has been no integration of the micro-hydro with other infrastructure projects. Hence, this hydro project earns a performance score of two, largely for the wanton tariff collection, and a score of zero for their project's integration with other development projects.

Interestingly, the tariff rate in Luwang Ghalel has *decreased* over time. As there were no outstanding loans by the time that the construction was completed, their cash reserves allowed a direct reduction of the tariff rate. In addition, Luwang Ghalel faced no major repair and maintenance issues, and the villagers there believe that the tariff rate will be at zero within a year (Mixed focus group discussion, Luwang Ghalel, 12 June, 2008). The villagers we interviewed did not seem to realize the need to continue

charging tariffs in order to keep pace with inflation. For these reasons, their project earns a performance score of zero for tariff collection.

At present, the Luwang Ghalel micro-hydro project has signed a 25-year agreement with Gandaki Hydro Power (GHP), a company also developing a small hydropower plant (producing 3.2 MW) in the same basin as that of Luwang Ghalel. Under this agreement, the Luwang Ghalel micro-hydro project is leased to GHP under the condition that when GHP starts producing power, it will give the Luwang Ghalel villagers 44 kW of power and the sum of $316.45 each month. GHP will also provide staff, repairs, and all maintenance for the micro-hydro project. Responsibility for project management will remain with the villagers, but GHP will have sole ownership of the equipment and stream used by the micro-hydro to generate its 44 kW of power. However, despite the economic benefit of their integration with GHP, Luwang Ghalel residents face severe environmental impacts from the project (see Table 8). For these reasons, the project earns a performance score of five for integration with other development projects.

Table 8

Environmental consequences faced by Luwang Ghalel VDC

Luwang Ghalel/Gandaki Hydro Project Environmental Impact:
Though villagers were unaware of any public hearing to allow environmental impact research, GHP performed an Environmental Impact Assessment (EIA). GHP obtained all the necessary permits to perform this assessment but failed to notify the villagers. Luwang Ghalel participants were angered since they felt ownership of the watershed project and wanted equal rights in any decisions made involving the micro-hydro generator. The villagers rioted in protest of changes made without their consent, and construction came to a standstill. Minimal compensation was provided on the behalf of the developers, but their plans remained mostly unaltered and catered to their own benefit. A temporary road was built to transport the developers' equipment into the village and they subsequently became the sole energy producer at the basin through their 25-year lease of the only successful 44 kW micro-hydro projects. Since money was valued over quality, the developer used shoddy and dangerous pipe work for the project. During research, the unfinished canals flooded all of the village's paddy fields. (The canals were built to deliver water from its source to the fields). The village was economically devastated as their only source of income for the winter was destroyed. The paddy fields are only a few feet away from the village, which left homes susceptible to the same flood conditions.

Subsidy/grants, local capacity, and availability of developers. According to its subsidy policy, the Nepalese government agrees to provide participating villages with $1,101.36 per installed kW for new projects in a range of 5 to 500 kW. Neither village could benefit as their micro-hydro projects were in operation before the subsidy policy became law.

The 1999 Energy Sector Assistance Programme (ESAP) subsidized 43% of the Luwang Ghalel micro hydro project. ACAP and BODF also supported the project, covering in grants fully half (50%) of its total cost. Due to these factors both projects

received an almost equal amount of grants. However, the villagers still had to contribute much of their own money and sweat equity to ensure the completion of the project. Therefore, both projects earned performance scores of eight for subsidies and grants.

Both projects focused on reducing operating costs rather than reducing their initial investment. Through their local capacity, both villages were able to reducing operating cost through providing both sweat equity and monetary contributions.

Ghandruk villagers are required to contribute three or four days of sweat equity per construction period. When designating which households would contribute during which period, Ward numbers played an organizing role. Typically, districts consist of nine wards. The area covering the Ghandruk micro-hydro project includes ward numbers three, four, five, six, and seven. Every household in each of these wards had to contribute three to four days of labor each week. Once this work is accomplished, responsibility rotates to the other wards. Rotation begins again at the end of this cycle, whether or not work was completed. Despite this system, the sweat equity and monetary contributions by the Ghandruk villagers only constituted 15% of the total project cost. Hence, the project earned a performance score of five for local capacity and input.

In an effort to bring down operating costs, the villagers of Luwang Ghalel were required to contribute 150 days of sweat equity for every construction period. Far ahead of Ghandruk, the sweat equity and monetary contribution by the villagers in Luwang Ghalel accounted for 57% of the total cost. It is for this stellar contribution that this project earns a performance score of 10 for local capacity and input.

For both projects, the involved NGOs provided significant financial and technical backing during the construction phase. Once the project began operating, the NGOs were generally not involved in project operation or maintenance.

According to Devendra Adhikari of AEPC,

> In community-based micro-hydro projects, the policy does not require the NGOs involvement post-completion of a project. Once the management committee is established, the community is responsible for the project. I understand that the community requires help with follow up, but what can we do if it is not a part of the policy? (Personal interview, Kathmandu, 5 July, 2008).

The limited resources of these NGOs restrict them from investing additional time and money into these projects. Both projects earn a performance score of 10 for the availability of NGOs during the construction phase and a five for NGO availability during the management phase.

Technical Performance and Project Efficiency

For the technical success and efficiency of a project, this study utilized the following indicators:

- Repair and maintenance cost covered by tariff collection
- High load factor (the actual consumption as a proportion of total possible generation)
- Financially sustainable end-use
- Subsidies cover all aspects of the project including end-use investments

- Presence of transparent and fair mechanism for the sale of micro-hydro electricity to the national grid

Repair and Maintenance. The Ghandruk micro-hydro project serves 243 households and generates a monthly income of $550 each month. On average, a household will use 100 W, and hotels generally use 1 kW. During the sixteen-year lifespan of the Ghandruk micro-hydro project, there were three major repair and maintenance issues. These problems largely concerned having to change the water source, the addition of new pipelines, and repairing the turbine and generator. The cost of the most recent repair and maintenance work is $14,815, but this amount does not reflect the sweat equity contributed by the villagers. The current cash reserve of the Ghandruk micro-hydro project is $660. The repair and maintenance cost is not covered by tariff collection alone, so the villagers must contribute through sweat equity. It is for these reason that the project earned a performance score of five for repair and maintenance work.

The Luwang Ghalel micro-hydro project serves 243 households and generates $264/month. On average, the project supplies 100 W/ household. There has been only one repair and maintenance issue over the project's lifespan and the total cost of this repair was approximately $100. The project earned a performance score of 10 for repair and maintenance work.

High load factor and sustainable end-use. The Ghandruk micro-hydro plant runs 24 hours/day with a very high load factor. Due to tourism, 24 local hotels use this

electricity to power their refrigerators, lights, televisions, and water heating. In addition, this project powers a stone cutting mill, which operates seasonally. With the exception of the mill, this micro-hydro project sees no productive and sustainable end-use (e.g. sawmills, milk-processing facilities, poultry farms, bakeries and noodle factories) that would benefit the entire village. Based on interviews, the villagers' most frequent complaint is that the micro-hydro benefits only a handful of the villagers, the hoteliers in particular. Ghandruk villagers want to divert the power from hoteliers to grinding mills, whose productivity could mean a potential raise in the socio-economic status of the entire village. The project earned a performance score of eight for high load factor.

The Luwang Ghalel micro-hydro plant shuts down every day from 10 AM to 3 PM. During the daytime hours, the villagers do not utilize power to its full capacity. The load factor is quite low when compared to Ghandruk. There is insufficient power output to provide villagers with electricity through the evening hours, and some villagers complain that lighting is too dim. Due to low energy output, there is a ban on rice cookers, as well as refrigerators and cable lines being used anywhere in the village. There is one seasonal stone cutting mill, but no other daytime sustainable end-uses for this micro-hydro electricity. The project earns a performance score of two for high load factor. Due to their agreement with GHP, Luwang Ghalel villagers' right to increase their power production has been restricted for the next 25 years. Hence, the project earns a performance score of two for sustainable end-use.

Despite an urgent need for additional power at Ghandruk, there has been no increase in power output at either micro-hydro project since operations began. Ghandruk villagers are anxious and wish to establish a new mill in the village. While the social status of the area has risen due to foreign employment, and every other house has acquired a refrigerator, television, and a stove, native residents are unable to make use of these luxuries because of the lack of available power. The Ghandruk project management committee is currently holding discussions with ACAP in an attempt to apply for government subsidies, which would allow the village to begin a second phase of the project that would use the same water source. At the time of this research, no work has begun on this project expansion. The government subsidy policy does not focus on sustainable end-uses. Given this data, the Ghandruk project earns a performance score of five for sustainable end-use.

Adding to the discussion above, ACAP officer Satya Naryan Shah explained that, "since the national grid has already come to the adjacent VDC, it might not be worth developing a second phase at Ghandruk. This micro-hydro project may have outlived its usefulness. It's been around for 17 years; two years longer than the average lifespan of a micro-hydro."

Sale of micro-hydro electricity to the national grid. Both groups of villagers are divided between the prospect of inviting the national grid into their area and the idea of getting rid of the micro-hydro project altogether. 52% of the respondents in Luwang Ghalel feel that micro-hydro a good thing for them because their current tariff rate is

cheaper than the one set by the NEA. If the national grid were extended to the village, villagers would incur an increased per hour charge, whereas usage of micro-hydro electricity is paid for at an inexpensive flat rate. By contrast, those villagers who want to use rice cookers and refrigerators as well as establish mills for economic development see a great future in extending the national grid to their village. Hence, the project earned a performance score of zero for possibility of sale of micro-hydro electricity to the national grid.

Fifty percent of the people in Ghandruk feel that the national grid will be a positive alternative, largely due to how the village is in dire need of more power for lighting as well as for productive end-uses. Despite these pressing needs, the possibility of selling micro-hydro electricity to the national grid looks slim because to do so, the National Electric Authority (NEA) would have to purchase the micro-hydro project from the local committee and at present they are unwilling to do so. This obstruction is one of the main reasons that electricity from the national grid is unavailable in Ghandruk. According to Govindha Pokhrel, the director of Rural Electrification at the NEA, "It is not cost-effective for the NEA to buy power from a 17 year old micro-hydro project, as there is no way to evaluate the quality of the equipment used or the reliability of the source, given that there were already three major repair and maintenance issues on the project." For these reasons, the Ghandruk project earned a performance score of zero for the possibility of the sale of their micro-hydro electricity to the national grid.

Technology Transfer

One specific success indicators for these projects is Technology Transfer to nearby villages. The micro-hydro project in Ghandruk offers one of the first success stories of its kind in Nepal. Despite repair and maintenance issues, it has produced electricity for the last 17 years. Spurred by Ghandruk's positive example, several other micro-hydro projects have sprung up in nearby villages. For instance, Chhomrong VDC established a 100 kW micro-hydro in February 2000. This 100 kW output micro-hydro plant was established over a period of three phases, so the initial output was low, but increased over time. Following this trend, many individuals in nearby villages purchased small-scale Peltric sets. As these Peltric sets were purchased by individuals, their dates of establishment are unknown. The Ghandruk project earns a performance score of 10 for technology transfer. Table 9 outlines some examples of these projects.

Table 9

List of Peltric sets near Ghandruk and Chhomrong VDC

Name of village	Capacity	Households served
Melanche	5 kW	58
Chulle	6 kW	84
Kimrong	3 kW	22
Ghandruk Deurali	1 kW	2
Doban	5 kW	5
Ghurjung	2 kW and 5 kW	70

Ghalel, a neighboring village to Luwang Ghalel, established a 12 kW micro-hydro project in 1998, which came to serve 105 households. However, the Ghalel project did not last long due to several technical and managerial problems. According to the

project's founder, Ram Bahadhur Gurung, "one of biggest failure was lack of trained operators and management. The generator broke down so many times due to the carelessness of the operator. The Management Committee did not spend money to train the operator, and we had to close the micro-hydro." For this reason, Luwang Ghalel earns a performance score of five for technology transfer.

Social Stability

Social Stability is another success indicator for these projects. The type of economic benefit that a project will bring to a village often defines its social stability. Due to its sheer number of new hotels, it is easy to assume that Ghandruk has benefited immensely from electricity provided by the micro-hydro generator. While tourism is the village's main source of income and the hotels use massive amounts of electricity to keep their guests happy, 73.3% of the villagers think that the micro-hydro power did not make a big difference in their lives because only a handful of hoteliers actually benefited. Due to power shortage in Ghandruk VDC, existing mills have ceased operating. For these reasons, Ghandruk earned a performance score of five for social stability.

One businessperson in Ghandruk VDC, Him Lal Pariyar, argues that he only receives 50 W of electricity, half of which he gives to his son. As a result, he lacks the necessary electricity for his household's daily needs. As a point of comparison, hotels in the same village have enough power for their guests to use refrigerators and televisions (Personal interview, Ghandruk, 12 May, 2008).

There is one seasonal stone-cutting mill in Luwang Ghalel VDC. It is only operational during the day. While many of the villagers wish to establish other income-generating mills, they are unable to do so due to lack of electricity. According to Gita Gurung, the manager of Luwang Ghalel micro-hydro project, the original goal for the project was to get electricity for lighting purposes only. They did not consider their potential future needs and are now facing the consequences. The Luwang Ghalel project earns a performance score of two for social stability.

User Satisfaction

User Satisfaction is also a success indicator for these projects, where the satisfaction level of beneficiaries often determines the overall success of a project. In Ghandruk, 40% of the villagers were satisfied with the project and 40% thought it was reliable. The Ghandruk micro-hydro project has existed for 17 years and even with three major repair and maintenances, it is running smoothly. However, available data shows that 60% of the villagers felt the project to be unreliable. At the time of data collection, a major landslide had destroyed all pipelines, and the power had been out for a week. This situation may have influenced the responses we received in our interviews.

Sixty percent of respondents thought their quality of life had improved with electricity. Villagers mentioned that it was now easier for their children to study, commenting that before the micro-hydro, their children had to study by kerosene lamp, which most felt to be unhealthy. The villagers also mentioned that the power affected

their cleanliness. They were able to see dirt more effectively now and were able to clean their homes better as a result. The project helped foster a stronger connection to the world was felt because more villagers could use radios and televisions. However, many residents also expressed the need for sustainable end-use and economic development for the entire village. In the end, the Ghandruk project earned a performance score of five for user satisfaction.

In Luwang Ghalel, 36% of the respondents were satisfied with the project and 70% felt the project was reliable. At the time of this interview, the Luwang Ghalel micro-hydro project had just signed a 25-year lease with GHP. Many of the villagers were skeptical about the future, even though the lease had passed by a 70% vote. 50% of the villagers felt that the project had improved their quality of life, with the other half feeling that that their quality of life would see further improvement if they received enough power to rice cookers and refrigerators. As in Ghandruk, villagers in Luwang Ghalel expressed the need for more sustainable end-use and economic development. The Luwang Ghalel project earns a score of five for user satisfaction with the project.

Environmental Effects

The effect of these projects on the watershed can also be considered an important factor when evaluating these micro-hydro generators. The Ghandruk micro-hydro project began in 1992, as part of ACAP's alternative energy program, which aimed to reduce stress on forest resources through electricity use. The program focuses on the promotion

of technology that minimizes wood consumption. In its micro-hydro policy, ACAP emphasizes the need for these plants to support micro-enterprise development as well as providing an alternative to wood fuel. Ghandruk has accomplished that goal. According to Satya Narayan Shah, since the introduction of electric heaters and stoves, villagers no longer have to use firewood for cooking or heating (Personal interview, Ghandruk 13 May, 2008). Therefore, the Ghandruk project earns a performance score of 10 for environmental effects in this village.

In contrast, environmental conservation was not seen as an important goal for Luwang Ghalel. Over the last six years of the Luwang Ghalel plant's operation, the villagers have yet to see the environmental effects of the project on fisheries or wildlife, although this may change due to recent GHP developments, as described in Table 8. For this criterion, the Luwang Ghalel project earns a performance score of five.

Overall Performance Score

The scores assigned for each evaluation criterion were then summed to arrive at an overall performance score. This score was calculated for three scenarios:

1. Ideal: Table 10 illustrates the ideal scenario. In this scenario, each indicator has an equal importance when considering the success of the project. I gave an equal weight to each indicator, a score of one.

2. Community-based: Table 11 illustrates the community-based scenario. In this scenario, each indicator is weighted based on what the community views as important

indicators of success. Based on field research and as discussed in the program evaluation chapter, indicators 1, 12, 14, 16, 17, 19, and 20 are more important than the others. Consequently, I assigned a weight of two for each of these indicators. The remaining indicators received a weight of one.

3. Expert-based: Table 12 illustrates the expert-based scenario. In this scenario, each indicator is weighted based what the experts in the field view as important project success indicators. Based on field research and interviews, indicators 1, 4, 7, 11, 13, 14, 17 and 20 are more important than rest. I assigned these a weight of two, while the remainder received equal weights of one.

I multiplied the performance score of each criterion by the associated weights in all three scenarios. I then added the weighted indicator scores to arrive at an overall micro-hydro project performance score. Performance scores for indicators 19 and 20 are based on data discussed in the program evaluation chapter.

Table 10

Overall Performance Score in an Ideal Scenario

No.	Indicators	Max	Luwang Ghalel	Ghandruk
1	Costs contained by good design	10	8	8
2	Detailed survey of hydro potential and energy demand	10	10	10
3	Effective management of installations	10	10	5
4	Collection of tariffs that keep pace with inflation	10	0	2
5	Integration with other developmental projects	10	5	0
6	Subsidies/grants should focus on increasing access by lowering the initial costs rather than lowering the operating costs	10	8	8
7	Local capacity and input	10	10	5
8	The availability, skills and other capacities of the project developer/ NGOs involved in the project during management	10	5	5
9	The availability, skills and other capacities of the project developer/ NGOs involved in the project during construction	10	10	10
10	Repair and maintenance cost should be covered by tariff collection	10	10	5
11	High load factor (the actual consumption as a proportion of total possible generation)	10	2	8
12	Financially sustainable end-use	10	2	5
13	Subsidies should cover all aspects of the project including end-use investments	10	0	0
14	Transparent and fair mechanism for the sale of micro-hydro electricity to the national grid	10	0	0
15	Technology Transfer	10	5	10
16	Social Stability	10	2	5
17	User Satisfaction	10	5	5
18	Environmental Effects	10	5	10
19	Management of the project	10	5	5
20	Well trained local operator and managers	10	10	10
	Total	200	112	116

Table 11

Overall Performance Score in a Community-based Scenario

No.	Indicators	Max	Luwang Ghalel	Ghandruk
1	Costs contained by good design	20	16	16
2	Detailed survey of hydro potential and energy demand	10	10	10
3	Effective management of installations	10	10	5
4	Collection of tariffs that keep pace with inflation	10	0	2
5	Integration with other developmental projects	10	5	0
6	Subsidies/grants should focus on increasing access by lowering the initial costs rather than lowering the operating costs	10	8	8
7	Local capacity and input	10	10	5
8	The availability, skills and other capacities of the project developer/ NGOs involved in the project during management	10	5	5
9	The availability, skills and other capacities of the project developer/ NGOs involved in the project during construction	10	10	10
10	Repair and maintenance cost should be covered by tariff collection	10	10	5
11	High load factor (the actual consumption as a proportion of total possible generation)	10	2	8
12	Financially sustainable end-use	20	4	10
13	Subsidies should cover all aspects of the project including end-use investments	10	0	0
14	Transparent and fair mechanism for the sale of micro-hydro electricity to the national grid	20	0	0
15	Technology Transfer	10	5	10
16	Social Stability	20	4	10
17	User Satisfaction	20	10	10
18	Environmental Effects	10	5	10
19	Management of the project	20	10	10
20	Well trained local operator and managers	20	20	20
	Total	270	144	154

Table 12

Overall Performance Score with Expert based Scenario

No.	Indicators	Max	Luwang Ghalel	Ghandruk
1	Costs contained by good design	20	16	16
2	Detailed survey of hydro potential and energy demand	10	10	10
3	Effective management of installations	10	10	5
4	Collection of tariffs that keep pace with inflation	20	0	4
5	Integration with other developmental projects	10	5	0
6	Subsidies/grants should focus on increasing access by lowering the initial costs rather than lowering the operating costs	10	8	8
7	Local capacity and input	20	20	10
8	The availability, skills and other capacities of the project developer/ NGOs involved in the project during management	10	5	5
9	The availability, skills and other capacities of the project developer/ NGOs involved in the project during construction	10	10	10
10	Repair and maintenance cost should be covered by tariff collection	10	10	5
11	High load factor (the actual consumption as a proportion of total possible generation)	20	4	16
12	Financially sustainable end-use	10	2	5
13	Subsidies should cover all aspects of the project including end-use investments	10	0	0
14	Transparent and fair mechanism for the sale of micro-hydro electricity to the national grid	10	0	0
15	Technology Transfer	10	5	10
16	Social Stability	10	2	5
17	User Satisfaction	20	10	10
18	Environmental Effects	10	5	10
19	Management of the project	10	5	5
20	Well trained local operator and managers	20	20	20
	Total	260	147	154

Overall performance score

Scenario	Luwang Ghalel	%	Ghandruk	%
Ideal	112	56	116	58
Community-based	144	53	154	57
Expert-based	147	56	154	59

In all three scenarios, the Ghandruk micro-hydro project scored slightly higher than Luwang Ghalel. Overall, both projects scored less than 60%. It is based on these results that I categorize both projects as fair. Both projects obtained inadequate financial support during the construction phase (see Tables 10, 11, and 12). This lack of funding led to a high villager contribution being required. The Management Committees overseeing both projects took no initiative, post-construction, to improve the economic status of the village by establishing financially sustainable end-use. At the macro level, all factors appear stable. At the micro level, there is a massive division between management of each project and their beneficiary communities.

Public Participation in Luwang Ghalel and Ghandruk Micro-hydro Projects

A community-based management system is the backbone of a micro-hydro project. The government of Nepal introduced micro-hydro projects in part to encourage rural communities to take responsibility for their own development. Seeing as the Nepalese government has been facing budget shortages, the community-based system cuts costs significantly for management and construction activity. Proponents of micro-hydro projects argue that since both Ghandruk and Luwang Ghalel operate with village-run management committees, full participation is occurring at the village level. However, no studies have been performed with regard to participation along lines of caste, ethnicity, or social stratification.

This chapter uses five criteria to evaluate the role of public participation in micro-hydro program effectiveness at village and committee levels. These criteria are as follows: opportunities and levels of decision-making, degree of ownership perceived, satisfaction with the process of participation, diversity of participants, and benefits and challenges of participation.

Opportunities and Levels of Decision-making

As discussed in the process of establishing a micro-hydro project, the micro-hydro projects in both villages are run by Management Committees. The members of this committee make all decisions regarding tariff rates, hiring staff, and setting salaries. They

are also responsible for all repair and maintenance work. While they meet monthly (and with increased frequency during emergencies) to discuss any issues related to the micro-hydro project, they hold full decision-making power.

Village level. To collect data on this variable, I asked the participants of both villages the following questions:

- Do you contribute to meetings?
- If so, what were your contributions?
- What was the frequency of meetings held?
- Were you active participants in the decision-making process?

The respondents were also asked if they felt their opinions were taken into consideration during the final decision-making process. In Ghandruk, (see Figure 5) 63% of respondents were under the impression that committee meetings were held monthly. 34% of the respondents reported attended the meetings "sometimes" while 70% "never" attended. When asked if they took part in the decision-making process, 36% said "sometimes" while the rest said "never".

In Luwang Ghalel, (see Figure 5) 100% of the participants were aware that committee meetings took place annually. They also knew that committee members met at monthly intervals. Villagers passed knowledge of meeting dates and locations by word of mouth. Thirty five percent said they attended the annual meeting "once in a while". When asked if they took part in the decision-making process, 35% said "sometimes" and the rest said "never". This data indicates that even though the villagers have knowledge

about frequency of meetings, they do not participate or involve themselves in the details of the decision-making process.

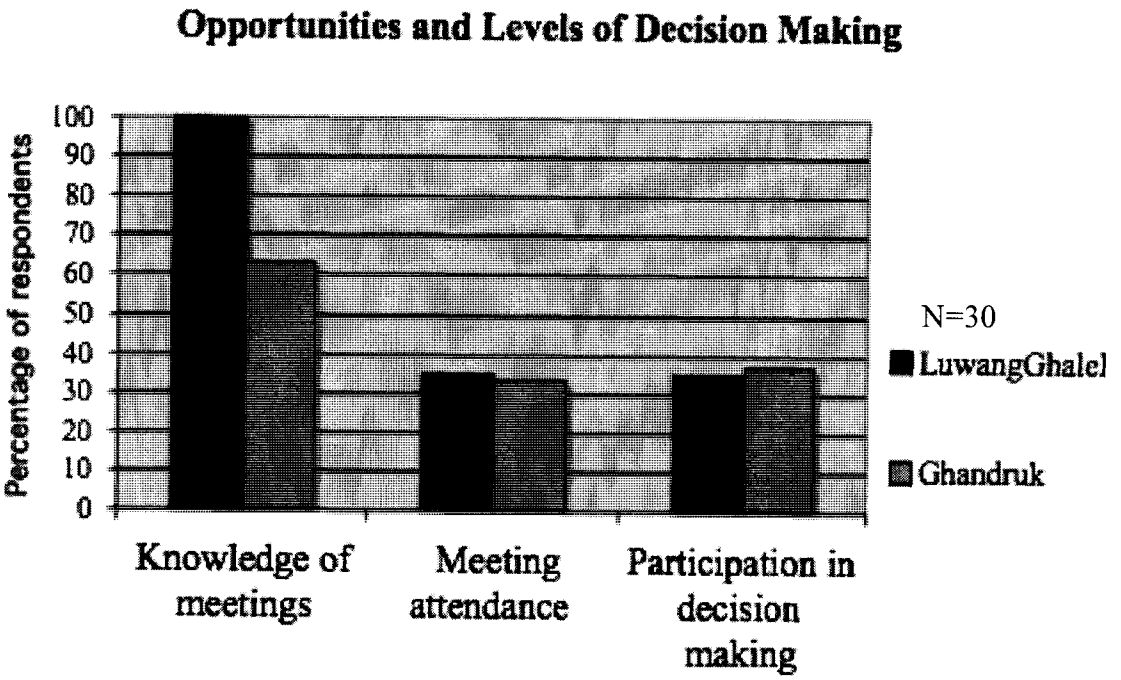

Figure 5. Opportunities and levels of decision making in Ghandruk and Luwang Ghalel

Based on field observations of both villages, one of the primary reasons for non-attendance at meetings is a perceived lack of transparency and poor communication between the Management Committee and villagers.

The following statement by Shyam Pariyar, a resident of Luwang Ghalel describes the way in which a typical meeting is run.

> The meetings are held every year, and management committee discloses financial information. Villagers can make complaints, if they wish. However, there is no follow up to the complaints. They do a meeting once a year where everyone from the village is invited. When we make complaints, we will have to wait next year to follow up. The committee hesitates to share financial information with us. They want to give the money to people they know and not to us (Personal interview, Luwang Ghalel, 16 June, 2008).

Residents in Ghandruk VDC echoed similar sentiments:

> There were several complaints made at the last meeting regarding dim electricity, requests for more power, tariff rates, etc. but none of the complaints were checked on. We understand that not all problems can be solved overnight, but it is the responsibility of the committee to reach out to us monthly or quarterly, so we know what is going on (Hari Dahal, Personal interview, Ghandruk, 14 May, 2008).

On the management side, however, those I interviewed offered a different perspective on the issue. Aita Bhadhur Tamanag, the President of the Luwang Ghalel micro-hydro project, told us the following: "Anyone can come to my house. I can show them the financial details. They are never interested, but are always talking behind my back" (Personal interview, Luwang Ghalel, 16 June, 2008).

Only a brief budget disclosure takes place at the annual meeting in Luwang Ghalel, where there is a general distrust among villagers regarding management of the cash reserves. Based on numerous conversations I had with the residents of Luwang Ghalel, most villagers spend their days busy in their farms and their most pressing concern is the feeding and support of their families. From this, I can conclude that the majority of these villagers view active participation in committee meetings as a luxury. Despite a low level of participation in actual meetings, residents are eager to obtain information about the project. Ninety percent of the respondents in Luwang Ghalel said

that they would participate in the meetings if given enough advance warning and were able to plan accordingly. When asked why he thought villagers were not interested in the project, resident Ram Pariyar of Ghandruk VDC explained that "The meetings are not called for the benefit of the villagers; whenever there is an increase in tariff rate or when they are called to contribute sweat equity. There is never good news and the villagers are not motivated to attend" (Personal interview, Ghandruk, 18 May, 2008).

Degree of Local Ownership Perceived

Committee level. Committee members on both projects work for little or no compensation. Members take a leadership role by organizing meetings during each developmental stage in order to ensure that villagers receive reliable electricity at a reasonable rate. According to Purna Bahadhur Gurung, chairman of Ghandruk micro-hydro project,

> I joined the committee because I wanted to do something for the villagers. Once I retired from the British Army and came back, I was really sad to see the plight of the village. When ACAP suggested establishing micro-hydro, I felt that it was a chance to do something. There is no hidden motive or agenda. Some villagers think that we are in it for the money, but even the micro-hydro projects itself is in debt, so how can we (members of the management committee) have the money? (Personal interview, Ghandruk, 15 May, 2008)

Village level. To understand ownership towards the project, I asked participants the following questions:

- Do you ever give suggestions or provide opinions at meetings?

- Do you ever take leadership in organizing meetings?
- Do you assist with repair and maintenance issues? If yes, how many hours do you spend working on micro-hydro related activities?
- Is remuneration provided for attendance at meetings or time spent at the micro-hydro project?
- Do you feel ownership towards the project?

In Ghandruk, (see Figure 6) 30% of respondents said they made suggestions "sometimes" while only 6% made suggestions "all the time". Seventy six percent of the respondents have helped with repair and maintenance issues at a frequency of three days per construction period[10] and also on an as-needed basis. Villagers also transported pipes from Nayapul to Ghandruk, a 6.2 mile, five-hour trek over steep terrain (ACAP 2007). They also assumed responsibility for the construction of the powerhouse. In order to extend transmission lines and pipelines from the water source to the village, villagers made an additional two-hour trek. (Purna Bahadhur Gurung, President of Luwang Ghalel micro-hydro project. Personal interview, Ghandruk, 15 May, 2008)

In Luwang Ghalel, (see Figure 6) 23% of the respondents made suggestions "always," and 90% of the villagers contributed 150 consecutive days of sweat labor during the construction period. Seventy three precent commented that they were ready to share repair and maintenance responsibility if required in the future. For the Luwang Ghalel project, villagers have not had to contribute their labor for the last five years.

[10]A construction period is the total time required to establish a micro-hydro project, which is typically between 12 and 16 months.

According to the Chairman of the Management Committee, the villagers do not have to shoulder the burden of repair and maintenance because the funds exist to hire labor when needed. Neither village provides remuneration for the sweat equity provided by the residents.

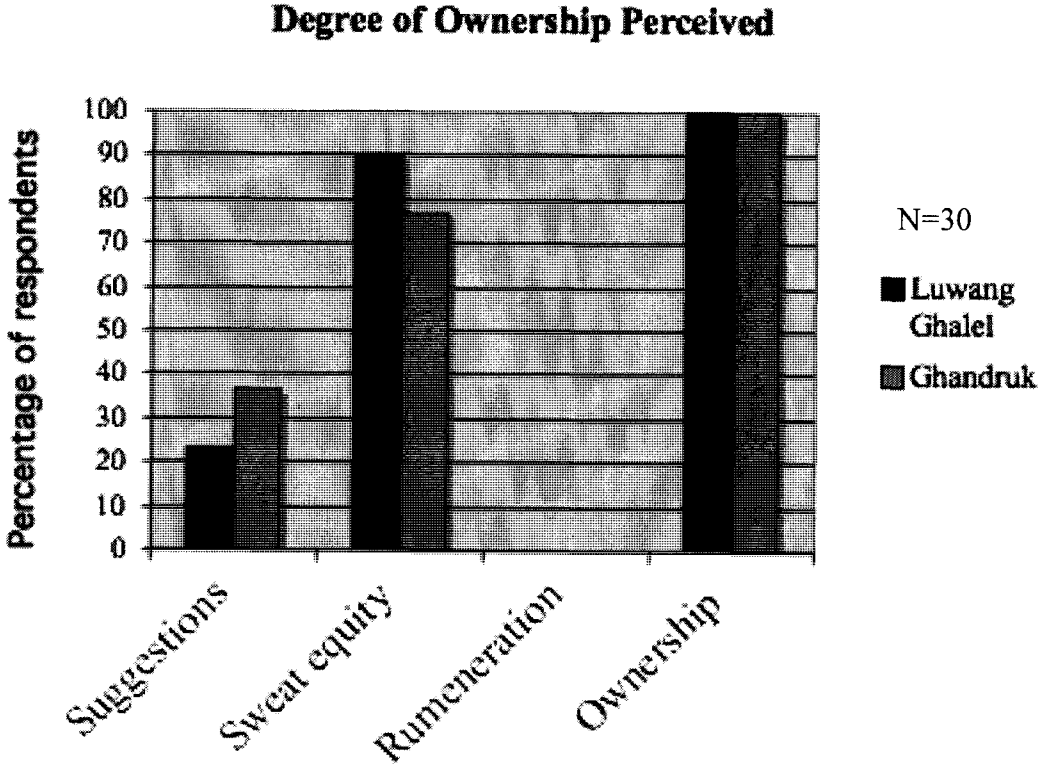

Figure 6. Degree of Ownership Perceived

Hundred percent of the respondents in both villages felt ownership of their respective micro-hydro projects. For example, Nina Gurung, one resident of Ghandruk VDC explained "We have given our sweat to bring the project. It belongs to the villagers

and not to the government. The people are attached to the project and take responsibility for running it smoothly" (Personal interview, Ghandruk, 12 May, 2008).

Similarly, Satya Narayan Shah, the ACAP officer assigned to Ghandruk states,

> The villagers are more responsible for the project if they are involved. Look at all the drinking water facilities built by the government. There is no running water after six months of construction. Since the villagers were not involved and it was a government owned utility, they do not care. However, look at the micro-hydro project. It is successfully running for 16 years. Even if there is a major problem due to landslides, the villagers themselves take the initiative and fix it (Personal interview, Ghandruk, 3 May, 2008).

Satisfaction with the Process of Participation

Committee level. All original members of the Luwang Ghalel Management Committee remain with the exception of the President. The ex-president remains involved with the project and serves as an advisor to the current committee. All members except the Manager expressed satisfaction with the process of participation for their projects. The Manager has felt some discrimination throughout the life of the project.

One of the ex-members of the Ghandruk Management expressed his dissatisfaction with the participatory process and has subsequently resigned his position:

> The micro-hydro operators are not disciplined and played cards while at work. They also did not stay full time at the powerhouse, which is their job. I am ex-army and cannot tolerate this kind of carelessness. I complained to other members, but no action was taken against the operators. I felt my voice was not heard, and hence I left the committee (Personal interview, Ghandruk, 20 May, 2008).

When I asked the Management Committee President, Purna Bahadhur Gurung, about this situation he replied with the following statement:

> The culture here is very different than in an army or business-style office. The operators are required to be at the powerhouse, but they do not have any significant work to do except to ensure that it is running smoothly. Besides that, they just sit there and wait. In that situation, even if they play cards, or take turns in staying at the powerhouse, I cannot take action against them (Personal interview, Ghandruk, 22 May, 2008).

Village level. To understand the amount of satisfaction the villagers felt in their participation, I asked them the following questions:

- Are you satisfied with the process of participation?
- Is your voice heard in the meetings?
- Do you feel the meetings are organized in a free and fair manner?
- Do you feel it is important to attend these meetings for the benefit of the community?

In Ghandruk, 42% (see Figure 7) of the villagers were "satisfied," with 36% claiming that the organization of the meetings was free and fair. Of the remainder, only 30% felt that their voices reached the committee. The Ghandruk villagers were moderately satisfied with the participatory process. This moderate satisfaction is due largely to how the community is able to voice their opinions consistently at the regular meetings, despite how there is rarely immediate action concerning their complaints.

In Luwang Ghalel, (see Figure 7) only 20% of the villagers reported being "satisfied" with the participation process, while a mere 18% considered the meetings to be organized in a free and fair manner, and 10% thinking that their voices were being

heard. Because meetings in Luwang Ghalel take place annually, the villagers are unable to make complaints or voice their opinions at regular intervals like those in Ghandruk.

Both groups of villagers feel acute social stratification due to the decision-making process. Ram Gurung, a villager living in the Luwang Ghalel VDC, explained his frustration with the process by asking, "What is there to make decisions about? They already make the decisions and we nod our heads. They will not change their opinion if we say no" (Personal interview, Luwang Ghalel, 11 June, 2008).

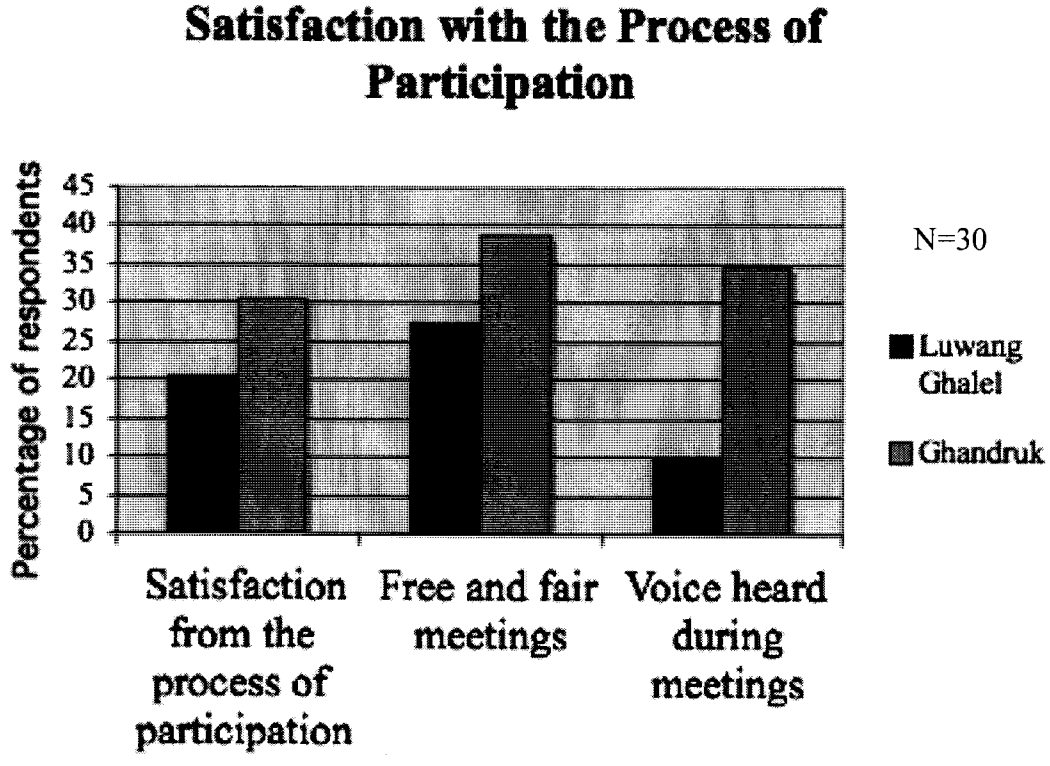

Figure 7. Satisfaction with the Process of Participation

Diversity of Participants

In this section, diversity of participants has been analyzed against gender, caste, and socio-economic stratification on both the village and committee levels. It is not within the scope of this study to quantitatively analyze the socio-economic status of the village; therefore, I gathered this information set through interviews and observation.

Committee level. In both Luwang Ghalel and Ghandruk, members of the major ethnic group are known as Gurungs. In addition, Brahmins[11] and Dalits are in the minority. As a consequence of this organization, the majority of committee members are from the Gurung community. The Nepalese government has recently dictated the requirement that both minority groups and women must have representation in all organizations. Under this new regulation, the village of Luwang Ghalel responded by creating a position for Dalit women, but this position is only on paper. According to 66% of our respondents, the "Dalit female" in question had only attended one meeting. She did not feel welcomed by the group and decided to stop participating (Mixed focus group discussion, Luwang Ghalel, 28 June, 2008).

Gender discrimination at the committee level. Luwang Ghalel's manager, Gita Gurung, is a woman and a member of the Development Committee. She feels her presence on the committee does not necessarily represent female liberation. She explains,

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[11]Brahmins are the highest caste in Nepal. Gurungs are a lower caste. However, there is a role reversal in Ghandruk and Luwang Ghalel because Brahmins are a minority in both villages and have a lower socio-economic status than the Gurungs. Dalits belong to the lowest caste, under Nepal's caste hierarchy system. (Focus group, Ghandruk, June)

> I became involved in the project because I was really interested and volunteered to go with the delegation team to Kathmandu. At first, others were reluctant to take me, but I was persistent. I attended all meetings and became a member of the Development Committee. When the management committee was formed, I expressed interest in being the manager. I have passed fifth grade, and can do basic calculations. The management committee hired me because they thought women will be more careful with money, and would not waste on alcohol or other things. Now I hear that there are rumors in the village that I am not qualified. After five years of work, how can I not be qualified? (Personal interview, Luwang Ghalel, 18 June, 2008).

Based on our field experience, the majority of these women still hesitate to leave their houses, and rarely participate in meetings or do project work. It was also very difficult to convince these women to share their opinions candidly. Potential respondents would say things like: "We do not know anything," "we are busy with our house," "ask the men," or "Please come back later, my husband is not at home right now".

The Ghandruk management committee has chosen not to follow the government's edict. Their management committee has no female or minority representation. The Chairman of Aama Samuya (Women's Foundation) has asked the Management Committee to respect the new law, but no action has been taken so far.

Caste discrimination at the committee level. In Luwang Ghalel, conflicts over ethnicity have been seen at the Management Committee meetings. Based on our interviews, field research, and focus group discussion, there seems to be an unequal distribution of labor between the micro-hydro operators. The senior operator of the Luwang Ghalel micro-hydro project is of the Gurung caste. The junior operator is a member of the Brahmin minority. The senior operator joined the project with some

experience while the junior operator had none. After many years of working together, the senior operator continues to cite his experience as an advantage over the other operator, but seldom visits the powerhouse or makes rounds to check for power misuse. Instead, the junior operator carries out all necessary day-to-day activities, and, out of necessity, sleeps in the noisy powerhouse, which many would consider uninhabitable. The senior operator only plays an active role in management of the micro-hydro when a major problem occurs. That being said, during all prior "major" problems, the senior operator was unable to find a solution and had to contact an outside expert.

I asked the president of the Luwang Ghalel micro-hydro project if he had knowledge of this discrimination, and if he did, why wasn't he working to remedy the problem. He said:

> The Development Committee made a contract with the senior operator that he would have life long job security provided he left his prior job at the time of hiring. At that time, we did not have any knowledge. We were desperate and wanted someone experienced on the team. Now we are stuck (Personal interview, Luwang Ghalel, 8 June, 2008).

In Ghandruk, the senior and junior operators are also respectively Gurung and Brahmin. When asked if there was any apparent conflicts or hostility between these groups, the Brahmin operator replied, "We have been working together for 17 years. I think that speaks for itself" (Personal interview, Ghandruk, 20 May, 2008).

Village level. To better understand the diversity of public participation in these projects, I asked interviewees the following questions:

- Which ethnic groups are most active in the process of participation?
- Do members from all socio-economic status participate in the meetings? Do affluent families get better say in such meetings?
- Do both male and females participate in the meetings? If yes, how many of each gender?

In Ghandruk, (see Figure 8) 100% of the villagers agreed that Gurungs were substantially more active in their participation. Sixty percent of the respondents claimed that villagers from all ethnic groups are present at the committee meetings, but many do not voice their opinions. Ninety percent of the respondents felt that affluent families' opinions were given more attention at the meetings. In addition, I found only 15% of the meetings to include women.

In Luwang Ghalel, (see Figure 8) 100% of interviewees said that Gurungs were the group that most actively participated. Sixty percent said that members from all ethnic groups are present at the annual meeting, and 95% thought that affluent families were favored. In addition, I found only 35% of the meetings to include women.

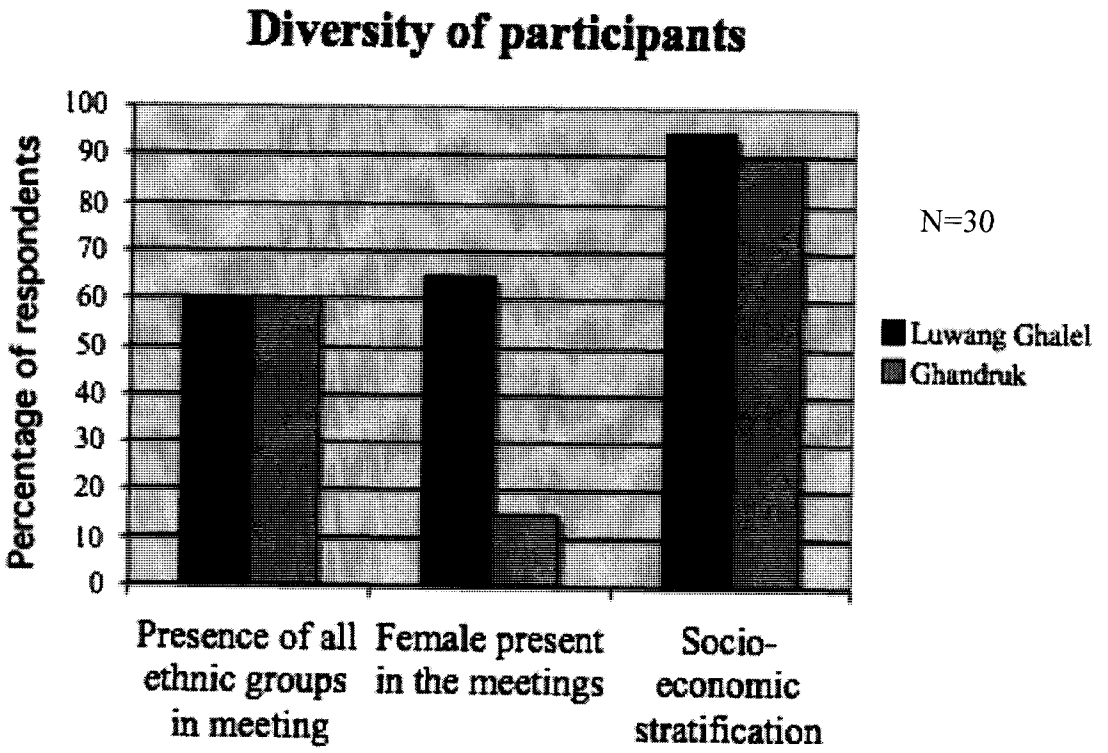

Figure 8. Diversity of Participants

Caste discrimination at the village level. Caste discrimination is evident at the village level in both of the villages I studied. In Ghandruk, one Gurung respondent said, "We are the majority in the village and have the capacity to make sound decisions. A Dalit would not have a capacity to make sound decisions. I do not understand how they have gotten equal rights, because they are not equal economically or socially with us" (Personal interview, Ghandruk, 16 May, 2008). While Dalits make up 25% of the

population in Ghandruk, members of the Dalit[12] population face constant discrimination and do not receive an equal and appropriate share of the electricity. In 2007, members of the Dalit population marched in protest to the ACAP office in Ghandruk . Chandan Biswakarma, a Dalit interviewee in Ghandruk, explained,

> Most of the Dalit houses have only 50 W of electricity. When sons leave to start their own families, we split power - and both parties are left with only 25 W to work with. When the Dalits are in such conditions, why do new hotels get 1 kW of electricity? If there was no power, then how can the new hotels have it, and the Dalits go without? (Personal Interview, Ghandruk, 19 May, 2008).

On the other hand, Lal-Kaji Gurung, the manager of the Ghandruk micro-hydro project, had a different story.

> In the beginning when the micro-hydro was established, only 32 kW were consumed. The Management Committee went door to door to sell electricity. At that time, the Dalits did not buy much. Currently, there is no family planning and a greater need for more electricity because family sizes have grown. The power they originally purchased is not enough. Now they complain about the new hotels. These hotels borrowed power from other hotels and not from the powerhouse itself. Some initially purchased more power than necessary and can now rent out their surplus. But the Dalits do not understand. In order to solve this problem, we used 2 kW of emergency power in order to provide all Dalits with 100 W of electricity (Personal interview, Ghandruk, 23 May, 2008)

In Luwang Ghalel, the Dalits feel discriminated against largely due to the Management Committee's refusal to provide them with loans. As previously explained, the Luwang Ghalel Management Committee is theoretically obligated to offer loans to

[12]Dalits are the lowest of all castes groups in Nepal, and are not allowed to enter temples or houses. While the caste system was constitutionally abolished, much prejudice remains.

the needy in that village. In stark contrast to this requirement, one Dalit woman explained how this practice will often actually work:

> I asked the Management Committee for a loan and was denied. My daughter is always sick and needs to see the doctor often, which costs money. They (Management Committee) play favorites and loan money to those they already know. I worked for 150 days during the construction period. How can they say I have no right to borrow? (Personal interview, Luwang Ghalel, 18 June, 2008)

I asked Aita Bahadhur Gurung, Chairperson of the Management Committee, about this situation. She said,

> Yes, it is true that Dalit woman asked for money. The committee requires a co-signer to guarantee a loan. This woman could not provide one. We all know her, but she has no stable source of income. How can we take this risk? It has nothing to do with gender or caste. In the past, we have lent the money to a Brahmin. They are a minority in this village. He had a co-signer and an income source. That is what matters (Personal interview, Luwang Ghalel, 20 June, 2008).

Socio-economic stratification at the village level. During a focus group discussion[13] in Ghandruk, the villagers made it clear that they did not agree with the existing distribution of labor and electricity. While many villagers felt that both low and high consumers of electricity must contribute equal labor, those who consumed only a small amount of electricity, many only using 50-100 W, felt that they should not have to contribute as much labor as those who consume ten times as much. Finally arriving at a consensus, the villagers agreed that the amount of labor required for the micro-hydro project should be higher for those who consume more of the energy it provides. One

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[13]Focus group discussion took place in Ghandruk during May 2008.

alternative to this idea was that the electricity ought to be divided equally amongst all contributors. One proponent of this idea, Ram Hari Bishwakarma, a minority resident of Ghandruk VDC illustrates this view:

> If they can divide the labor equally then they should also divide electricity equally. If the hotel owners can get 1000 W of electricity compared to my 50 W but only work for three days like me, then it is not fair. If the hotel owners cannot provide a week of labor contribution then they do not have the right to consume so much electricity (Personal interview, Ghandruk, 8 May, 2008).

The topic of power and labor distribution remains a source of animosity and contention in that village.

Gender discrimination at the village level. During our Ghandruk focus group discussion, female participants complained that the division of labor was insufficiently gender-specific, that is, the current situation was not based on contributions appropriate to women. While most of the women in the village understood that they must volunteer labor hours to provide electricity to their household, they expressed a desire for less physically strenuous work. Based on interviews I conducted, most of the women would not mind clearing forests for pipelines, cooking for workers, or similarly low-impact tasks. Many stated, though, that they had a difficult time carrying pipes and construction materials long distances, tasks that village men had little difficulty completing. Maya Devi, a resident in Ghandruk describes her hardship:

> My husband is in Dubai. I have two kids. I have to do all household chores, send my kids to school, work on my farm and on top of that, I have to contribute labor to the project. I understand that I have to contribute labor, but trekking five hours

> every day kills my back. I cannot work that hard. I wish the management committee would give easy chores to the women of this village (Personal interview, Ghandruk, 17 May, 2008).

The president of the Ghandruk micro-hydro project offers the opposite view. He explains that "all the young men have gone to Dubai. There is no one in the village except the elderly, women and children. If we all do not work, who else will? If they do not want to work than they can always pay more money" (Personal interview, Ghandruk, 18 May, 2008).

Benefits and Challenges of Participation

Committee level. In both projects, all committee members agreed that their respective projects were of immense benefit to not only the community, but also for themselves. According to Tek Bahadhur Shrestha, ex-President and founder of the Luwang Ghalel micro-hydro project,

> I feel proud that I was able to do something for the community. I have gained much in the process. We villagers could not even speak properly before, but now we are able to send village delegations to officers in Kathmandu. Because of this project, our quality of life has increased and we feel connected to the real world. It is a great achievement on our part (Personal interview, Luwang Ghalel, 12 June, 2008).

Purna Bahadhur Gurung, President of Ghandruk micro-hydro project shared similar sentiments.

> This project is not merely represented by a powerhouse that provides electricity. It is a symbol of our hard work and dedication. Even if the government does not help us, we can help each other and achieve the impossible. Today, electricity is not that difficult to harness. 16 years ago, however, it was perceived as impossible and we did it (Personal interview, Ghandruk, 24 May, 2008).

Committee members from both villages agree that they have faced numerous challenges during the establishment of their respective micro-hydro projects. According to Aita Bahahdur Gurung, one of the biggest challenges has been the lack of professional guidance during the establishment of the generator. He said, "I am not really qualified to make decisions that will benefit the community. When we had to lease our micro-hydro project to Ghandaki Hydro project, there was no one to tell us if it was a good decision or not. I still do not know if we made a good decision" (Personal interview, Luwang Ghalel, 25 June, 2008).

The Luwang Ghalel Management Committee faced considerable problems during their project's construction. DCRDC pledged to make available both an engineer and staff to oversee the construction, but none were provided. The Development Committee had to take much initiative and ended up drafting their own construction contract for the builders. DCRDC did help the villagers come up with a cost plan/quote for the project, allowing Luwang Ghalel to shop around for different building companies. That village's management committee eventually chose AC Power Company to build the project.

Tek Bahadhur, ex-president of the Luwang Ghalel micro-hydro project recalls the confusion of the bid process:

> I was so confused by all the different offers I received from builders. I wasn't familiar with the technical terms. Some were cheap. Some were expensive. I didn't know how to decide. We went with the most expensive because we thought it might be better. DCRDC helped us a lot, but in many ways, we were on our own (Personal interview, Luwang Ghalel, 13 June, 2008).

Worse than these organizational issues, the Manager of the Ghandruk micro-hydro project argues that the biggest challenge they've faced has been the random devastation of natural disasters. He says,

> We simply selected the site that we thought was best. We didn't know it was an area prone to landslides. There is now a provision to conduct site assessments before construction can begin. I am not sure why ACAP didn't tell us this. We face seasonal impacts regularly and have spent significant amounts dealing with repair and maintenance (Personal interview, Ghandruk, 14 May, 2008)

Village level. To better understand the benefits and challenges faced by these villagers, I asked participants the following questions:

- Do you think you have gained knowledge about the micro-hydro project through your participation?
- Do you think you are able to make informed decisions about the micro-hydro project?
- Do you think participation has increased your self-confidence?
- Do you think community participation is important at a meeting?
- Do you think your participation in the project matters?
- Do you think the project has benefited the community?

In Ghandruk, 53% of the participants believe that, through the meetings, they have gained knowledge about the micro-hydro project. Forty one percent of the villagers believe that they are able to make informed decisions about the project. While 70% of the villagers believe that participation is important, only 30% think that their self-confidence has improved through their participation.

In Luwang Ghalel, 45% of the participants believe that they have gained much knowledge about the micro-hydro project at that village's annual meetings. While 85% of the villagers believe that participation is important, only 36% believe that they are able to make informed decisions about the project and only 35% think that their self-confidence has increased through their participation. Ram Hari Gurung of Luwang Ghalel explains, "Without our participation and 150 days of hard labor, how could the micro-hydro have been established in the first place?" (Personal interview, Luwang Ghalel, 28 June, 2008).

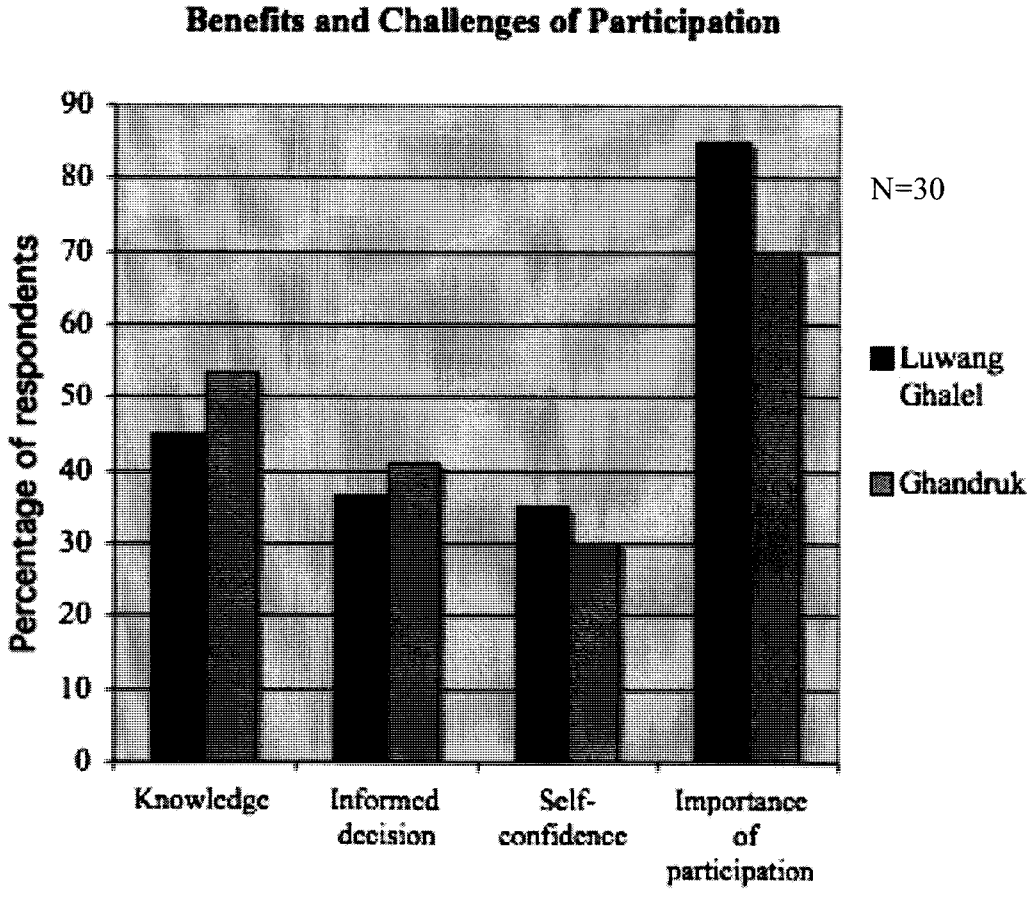


Figure 9. Benefits and Challenges of Participation

Our respondents understand the importance of community involvement but have expressed a desire for the committee meetings to be more interactive and truly participatory. The villagers in Luwang Ghalel want the frequency of their meetings increased to, if not monthly, than at least quarterly so that they can more easily share their concerns and complaints.

Table 13 quantitatively illustrates the villagers' participation levels in the two projects with regard to the evaluative criteria used in this study. To obtain the overall participation level for both projects, I first calculated the arithmetic mean for all the sub-criteria based on the results discussed above. Once I had the overall mean from the data, I categorized the results into "low", "moderate" or "high". If less than 40% of the respondents offered a positive rating for a criterion (e.g. diversity of participants), then that response was categorized as low. If 41 to 60% rated the project positively for a criterion, it was rated as "moderate" participation. If 61% or more of respondents offered a positive rating, it fell into the "high" category. For example, under the heading of whether villagers were "satisfied with the process" from the project, I received positive ratings from 19.2% of Ghandruk respondents and 34.6% in Luwang Ghalel. Based on this categorization scheme, I categorized overall resident satisfaction from the project in Ghandruk and Luwang Ghalel to be "low." Similarly, I categorized overall opportunity and levels of decision-making, degree of ownership perceived, and benefits and challenges of participation at both villages to be "moderate".

On the other hand, diversity of participants and satisfaction from the project was "low". Table 13 illustrates how, in respect to the overall participation at the village level, Ghandruk rates slightly higher than Luwang Ghalel. However, this difference is slight and not significant. Both projects failed to integrate villager participation with project management, and thus both failed to meet one of the major goals of the community-based micro-hydro project.

Table 13

Overall Assessment of Participation

Opportunities and decision-making	**Luwang (%)**	**Ghandruk(%**
Knowledge about meetings	100	63
Frequency of meeting attendance	35	33
Participation in decision-making	35	36
Average	56	44
Overall	Moderate	Moderate
Degree of ownership perceived		
Suggestions in meetings	23	36
Help with repair and maintenance	90	76
Remuneration for sweat-equity	0	0
Ownership towards the project	100	100
Average	53	53
Overall	Moderate	Moderate
Satisfaction with the process		
Satisfaction with the process of participation	20	30
Free and fair meetings	27	38
Voice heard during meetings	10	34
Average	19	34
Overall	Low	Low
Diversity of participants		
Lack of caste discrimination	40	40
Lack of Gender discrimination	35	15
Lack of socio-economic stratification	5	10
Average	26	21
Overall	Low	Low
Benefits and challenges of participation		
Knowledge from the project	45	53
Informed decision about the project	36	41
Increased self-confidence	35	30
Importance of participation	85	70
Average	50	48
Overall	Moderate	Moderate

Public Participation and Program Effectiveness

With regard to the third research question, whether public participation effects overall project effectiveness, I compared the performance and participation level of the two villages using twelve combinations of independent and dependent variables (e.g., sub-variables comparing public participation vs. project performance) shown in Table 14.

In conducting this comparison, I used an analytical method known as pattern matching (Trochim, 1985), where the case study results were compared to possible relationships based on previous related research. For example, one relationship suggested by the literature is that high levels of opportunities and levels of decision making are correlated with similarly high levels of the project's positive impact on village social stability. These predicted relationships are illustrated by the dotted line in Table 15 through Table 26. If the performance of the project for any combination of variables fit the predicted pattern, this supports the assertion that that there is a possible association between the two variables.

Data for comparison for the public participation variables was utilized from the results shown in Table 13. Values for project performance variables came from the results shown in Table 10. In order to make similar comparisons, project performance data was categorized as "low", "moderate" or "high". For example, if the performance score for a particular criterion was between 0-3, the village's performance level was rated as "low." If the performance score was between 4-7 for some criterion, the project's

performance level was rated as "moderate," and if the performance score fell between 7-10, the project performance level was rated as "high". For example, for the criterion of "social stability," the performance score for Luwang Ghalel was two, and the score for Ghandruk is five. Based on this categorization scheme, I rated Luwang Ghalel's social stability as "low," and Ghandruk's social stability as "moderate."

Table 14

Relationships to test

Public participation variables		Program evaluation variables
Opportunities and Levels of Decision-making	×	Technical Performance
		Social Stability
		User-satisfaction with the Project
		Sweat Equity
Degree of Ownership Perceived	×	Technical Performance
		Sweat Equity
Diversity of Participants	×	Technical Performance
		Social Stability
Satisfaction with the process of Participation	×	Technical Performance
		Satisfaction with the Project
Knowledge from the Project	×	Satisfaction with the Project
		Technical Performance

Luwang Ghandruk

Table 15: Opportunities and Levels of Decision-making vs. Technical Performance

	Technical Performance		
	LOW	MOD	HIGH
Opportunities and Levels of Decision-making			
LOW			
MOD			
HIGH			

In Ghandruk, technical performance is positively associated with opportunities and levels of decision-making. There is no association across the two villages.

Table 16: Opportunities and Levels of Decision-making vs. Social Stability

	Social Stability		
	LOW	MOD	HIGH
Opportunities and Levels of Decision-making			
LOW			
MOD			
HIGH			

In Ghandruk, social stability is positively associated with opportunities and levels of decision-making. There is no association across the two villages.

Table 17:

Opportunities and Levels of Decision-making vs. User Satisfaction from the Project

	User Satisfaction		
	LOW	MOD	HIGH
Opportunities and Levels of Decision-making			
LOW			
MOD			
HIGH			

User satisfaction from the project is positively associated with opportunity and levels of decision-making both within and across the villages.

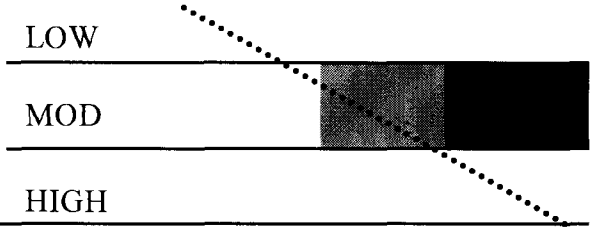
Table 18: Opportunities and Levels of Decision-making vs. Sweat Equity

	Sweat Equity		
	LOW	MOD	HIGH
Opportunities and Levels of Decision-making			
LOW			
MOD			
HIGH			

In Ghandruk, sweat equity is positively associated with opportunities and levels of decision-making. In Luwang Ghalel, there is no association between these variables. No association is seen across the villages.

Table 19: Degree of Ownership Perceived vs. Sweat Equity

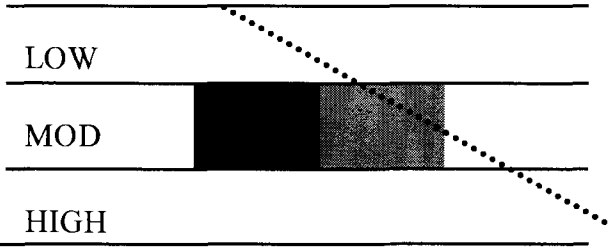
	Sweat Equity		
	LOW	MOD	HIGH
Degree of Ownership Perceived: LOW			
Degree of Ownership Perceived: MOD			
Degree of Ownership Perceived: HIGH			



In Ghandruk, sweat equity is positively associated with degree of perceived ownership. In Luwang Ghalel there is no association between these variables. No association is seen across the villages.

Table 20: Degree of Ownership Perceived vs. Technical Performance

	Technical Performance		
	LOW	MOD	HIGH
Degree of Ownership Perceived: LOW			
Degree of Ownership Perceived: MOD			
Degree of Ownership Perceived: HIGH			



In Ghandruk, technical performance is positively associated with degree of perceived ownership. In Luwang Ghalel there is no association between these variables. No assocation is seen across both villages.

Table 21: Diversity of Participants vs. Technical Performance

	Technical Performance		
	LOW	MOD	HIGH
Diversity of Participants LOW			
MOD			
HIGH			

In Luwang Ghalel, technical performance is positively associated with the diversity of project participants. In Ghandruk, there is no association between these variables. No association is seen across the villages.

Table 22: Diversity of Participants vs. Social Stability

	Social Stability		
	LOW	MOD	HIGH
Diversity of Participants LOW			
MOD			
HIGH			

In Luwang Ghalel, social stability is positively associated with the diversity of participants. In Ghandruk, there is no association between these variables. No assocation is seen across the villages.

Table 23: Satisfaction with the Process of Participation vs. Satisfaction with the Project

		Satisfaction with the Project		
		LOW	MOD	HIGH
Satisfaction with the Process of Participation	LOW			
	MOD			
	HIGH			

In both villages, satisfaction with the projects is not associated with satisfaction in the participation process.

Table 24: Satisfaction with the Process of Participation vs. Technical Performance

		Technical Performance		
		LOW	MOD	HIGH
Satisfaction with the Process of Participation	LOW			
	MOD			
	HIGH			

In Luwang Ghalel, technical performance is positively associated with satisfactory participation. In Ghandruk, there is no association between these variables. No association is seen across the cases.

Table 25: Knowledge from the Project vs. Satisfaction with the Project

	Satisfaction with the Project		
	LOW	MOD	HIGH
Knowledge from the Project: LOW			
Knowledge from the Project: MOD			
Knowledge from the Project: HIGH			

In both villages, knowledge from the project is not associated with satisfaction from the project.

Table 26: Knowledge from the Project vs. Technical Performance

	Technical Performance		
	LOW	MOD	HIGH
Knowledge from the Project: LOW			
Knowledge from the Project: MOD			
Knowledge from the Project: HIGH			

In Ghandruk, technical performance is associated with knowledge gained from the project. In Luwang Ghalel, there is no association between these variables. No association is seen across both villages.

Data from this study strongly indicated that, participation and program effectiveness are positively associated in Ghandruk (see tables 15, 16, 17, 18, 19, 20, and 26). There are several possible explanations for these results. One reason is the age of the

project. The Ghandruk micro-hydro generator has been in service for 17 years, and over this period, many villagers provided sweat-equity toward the necessary repair and maintenance work. Because of this work, they feel ownership towards the project. In addition, it is also due to Ghandruk's monthly meetings (as opposed to Luwang Ghalel's annual meeting) that the villagers feel that they hold some ownership of the project. In addition, as the national grid has not yet reached Ghandruk, and micro-hydro is their only power source, these villagers feel that their labor is necessary and valuable.

In contrast, for Luwang Ghalel, association appears much weaker (see tables 17, 21, and 24). One of the major reasons that Luwang Ghalel does not have the high levels of participation seen in Ghandruk, is likely due to its close proximity to the national grid, and the fact that all the villages adjacent to Luwang Ghalel receive electricity from the national grid. In fact, Luwang Ghalel has had the option of joining the national grid for many years. In this situation, villagers do not have the same personal project attachment as seen in Ghandruk.

However, there was a positive pattern seen across both Luwang Ghalel and Ghandruk in terms of opportunities and level of decision-making and user satisfaction. Based on my field observation and interviews, these two variables were one of the most important ones, because lack of knowledge, participation, and opportunities in decision-making frustrated many villagers.

Conclusion and Recommendations

The final chapter serves two purposes. First, it presents our research findings based on performance and identifies the larger policy implications of these findings. Second, it provides recommendations for developing long-term viable micro-hydro projects in Nepal and elsewhere.

This research has identified two inter-related reasons that explain performance: 1) an overall lack of capability for long-term project planning; and 2) gender, caste, ethnic group, and socio-economic stratification. Based on our program evaluation, the results show that both projects are fair in terms of overall performance. A closer look at the evaluation table also shows that while, on a technical level, the projects did very well in terms of funding, detailed survey and design, and reliability, they performed poorly in user satisfaction, social stability, sustainable end-use, and tariff collection. The management committees at both sites lacked the necessary initiative and insight to strategically manage either micro-hydro project. Both communities are in dire need of more electricity both for personal use and for economic development, but no provision exists at either project that would increase the overall power output.

As seen by both the micro-hydro project promoters and the Nepalese government, these projects appears to be successful because they appear to have performed well when rated by the criteria and metrics that have been used historically to evaluate these projects (e.g., high rates of villager participation). However, a closer look at these projects'

impact on different stakeholder groups reveals that many important development issues remain unaddressed. In particular, large amounts of social and financial investment have been levied into a development project that cannot meet either current or future demand for electricity. The results of this study show that the projects examined are, at best, a temporary solution for these villagers' electricity needs.

Social, managerial, technical, and financial problems identified in our research section were seen in both case studies. As reported by Gupte (2003), gender, caste and socio-economic stratification still exist in Nepal. These inequities are seen in the two cases studied here. There has been an unequal distribution of benefits, and this fact has become a major hindrance to both micro-hydro projects. In Ghandruk, members of the Dalit population face strict electricity rationing and artificial shortages due to caste discrimination. In Luwang Ghalel, gender and caste discrimination occurs even at the committee level. Furthermore, these results support the findings of Khennas and Barnett (2000), who argued that financial constraints remain major barriers to effective development of such projects. More specifically, the sweat equity was so high in Luwang Ghalel that it became a huge opportunity cost for villagers, who spent thousands of hours working on a project that, once completed, could not even meet their basic household electricity needs.

Applying Arnstein's (1969) ladder of participation to this study, the committee members I interviewed fall under the category of "Citizen Power." Project managers and operators fall under "Tokenism," and lastly the villagers themselves fall under the

category of "Nonparticipation." In both villages, opportunity and levels of decision-making in each project are limited to committee members. These members make all of the major decisions regarding the micro-hydro project, including setting tariff rates, managing human resources, investing funds, and extending transmission lines. Committee members are directly involved and maintain full control over the process. While project managers and operators are also involved in the process and do voice opinions, they do not exercise any control over decision making.

As seen in both projects, project managers and operators are those who keep the system running. In contrast, operators in both villages have been working on this project tirelessly since its establishment. This involvement reflects a high level of vital participation with no control over the decision-making process. Lastly, the villagers are at the bottom of this hierarchy, as their participation is next to minimal. While the villagers attend committee meetings and provide feedback, their voices are rarely heard, and there is no direct response to their complaints. From this, it can be argued that the meetings are more informational briefings than interactive decision-making. As Arnstein points out, this type of meeting is an example of the façade created by the management committee to make it seem that they have involved the villagers in their decision-making process. In addition, a lack of education affects social and managerial decisions. Socio-economic stratification still exists in Nepal, over which there is no system of checks and balances. Within this management style, the minority remains a minority and faces insurmountable difficulty becoming a part of the process.

This study provides a comprehensive framework that is more reflective of actual performance to the community when evaluating project effectiveness. The two villages selected for this study offer a best-case scenario for project development, based on their mountainous terrain and the availability of water resources for establishment of micro-hydro. Despite these favorable conditions, these projects do not seem to be working. From this failure one can begin to question the appropriateness of micro-hydro technology for meeting Nepal's future electricity demands at the village level. However, given the current power shortage crisis plaguing Nepal, coupled with the lack of capacity to construct large-scale sustainable hydro projects, micro-hydro generators can be a viable alternative but only after significant changes are made in the micro-hydro policy and strategies for implementation. Recommendations for developing long-term viable micro-hydro projects are as follows.

Equal Distribution of Benefits

Based on unequal distribution of benefits seen in both research sites, the Village Management Committee seek greater transparency and focus on effective communication between themselves and the public. Meetings should occur with greater frequency in both villages. Management should use their public platform to proactively discourage gender, caste and socio-economic stratification.

Accommodation of Increased Project Capacity and Site Selection

As seen in both projects, power shortages are one of the major problems impacting the villagers. These projects need to accommodate the increased demand for electricity-generating capacity as their dependent communities grow and change. Also, current projects are vulnerable to natural disasters, so it is necessary that long-term project viability be an important factor in site selection.

Reassessment of Sweat Equity and Subsidy Policy

As seen in this study, both villages had much difficulty in meeting the project's 50% sweat equity requirement. Our findings indicate that government should mandate policy changes that would require they compensate 80% of the total cost for the micro-hydro project. It is more likely that the villagers would be able to provide a 20% difference, as opposed to what they currently provide. Increase in tariff rates is also necessary over time, to adjust for inflation. Subsidy policy should also be mandated to encourage provisions for sustainable end-use.

Creation of Ongoing Support

Based on our field observation, I found that various funding organizations, donors and involved NGOs only provide support during the pre-establishment of the micro-hydro project. However, Management Committees require clear guidance on how to establish sustainable end-use projects in their respective villages. Hence, ongoing support should be provided following the initial phases of the project.

Job Training for Operators/Managers

Based on technical performance at both villages and the low level of technical training provided to operators and managers, funding agencies should supply each project with a designated field engineer who can provide technical support during at least the generator's first year of operation. In order to achieve project success, all operators and managers need to be properly trained on-site.

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Appendices

Appendix A: Semi-structured interview questionnaire (Project Consumers)

San José State
UNIVERSITY

Date ..... Time.....Interviewer ID: ..... Age: .....
Sex:..... Occupation:..... Ethnicity: .....

PC (a) Opportunities and levels of decision-making

1. Do you participate in meetings related to MHP? Why/Why not?

2. What does participation in these meetings mean to you?

3. How often do the meetings take place?

☐ Monthly ☐ Bi-weekly ☐ Weekly ☐ twice a week ☐ other.....

4. How often do you go to the meetings? If not, why?
☐ Every time ☐ Sometimes ☐ Once in a while ☐ Never ☐ other.....

4. (a) How do you get information about the meetings?

☐ Word of mouth ☐ Fliers ☐ Invitation cards ☐ Announcement through local radio ☐ other.....

(b) Does everyone receive information from the same source? Why/Why not?

5. (a) Who prepares the agenda for the day?

(b) How is it prepared? What are the topics discussed generally?

(c) How long are the meetings?

6. (a) Do you participate in the decision-making process? How involved are you?

(b) How often?
☐ Always ☐ Sometimes ☐ Never

7. Describe the decision-making process? Who is the facilitator? How is he chosen? Is there a voting system?

8. Do you feel your voice is heard during the community meetings?

PC (b) Degree of local ownership perceived

1. Describe your involvement with the MHP. Are you an active or passive member?

2. Do you ever make suggestions or give your opinions in any meetings? Why/Why not?

(b) How often?

☐ Every time ☐ Sometimes ☐ Once in a while ☐ Never ☐ other.....

2. Do you take leadership in organizing the meetings in any way?
Yes.....No.....
How? Why/Why not?

3. Do you help in the repair & maintenance of the MHP? How? Why/why not?

4. How many hours do you spend working for MHP related activities per month? Do you provide any technical/financial support to the MHP?

5. Do you get any kind of remuneration for attending or spending time for the MHP? Yes..... No..... If yes, $/month..... or describe the compensation you receive.

PC(c) Satisfaction with the process of participation

1. Are you satisfied with the process of participation in community meetings? Why/Why not?

Very satisfied		Neutral		Not satisfied
5	4	3	2	1

2. Do you feel recognized in the meetings? Please describe your experience.

3. Do you feel the meetings are organized in a free and fair manner?

Very fair		Neutral		Not fair
5	4	3	2	1

4. Do you feel you are making a difference in the community by participating in these meetings? How?

PC (d) Diversity of participants

1. Which religion/ethnic group do you belong to?

☐ Hindu/Gurung ☐ Hindu/Brahmin ☐ Buddhist/Gurung ☐ Buddhist/Brahmin ☐ other.....

2. Are there members from your ethnic group involved in the MHP? Why/Why not?

3. Which ethnic group is more active in the process? Why/Why not?

☐ Hindu/Gurung ☐ Hindu/Brahmin ☐ Buddhist/Gurung ☐ Buddhist/Brahmin ☐ other.....

4. Do members from all socio-economic status participate in the meetings? Do affluent families get better say in such meetings? Why/Why not? Can you provide example of such an incident?

4. Do both males and females participate in the meetings? Why/Why not? What is the ratio of male participation vs. female participation?

PC (e) Benefits and challenges of participation

1. Do you feel you have gained knowledge about the MHP through participation?
Yes.....No.....

Do you think this knowledge is helpful? How?

2. Do you think you are able to make informed decision about the MHP?
Yes.....No.....

Do you think this information was necessary for you and the community? Please explain.

3. Do you think participation has increased your self-confidence?
Yes.....No.....

How?

4. Do you feel your participation in the meetings has helped the community as a whole?
Yes.....No.....

How?

Do you think participation is important in your community? Why?

5. Do you think there has been in increase in tourism after the project has been established?
Yes.....No.....

Do you think your participation in the project has made this difference? How?

6. Has there been any big infrastructure development like roads, public health posts, post office after the MHP was established?
Yes.....No..... Name of such
development.....

Do you think this development had anything to do with the MHP? In what ways do you think your participation in the project initiated these developments?

7. Do you feel any kind of resistance socially to not participate in such meetings? Please explain the kinds of resistance and why?

8. Do you think participation in the project has improved the status of the village? How?

9. Do you recommend similar projects in future?
Yes.....No.....

Is there a similar project established in nearby village, after your village?

PU (7) User-satisfaction with the project

1. Are you satisfied with the way MHP is working?

Very satisfied		Neutral		Not satisfied
5	4	3	2	1

2 (a) How reliable do you think the system is?

Very reliable		Neutral		Not reliable
5	4	3	2	1

(b) For how many hours/per days you get access to electricity?

(c) Do you have load shedding? If yes, for how long?

(d) Do you pay for the electricity you get? How much?.....Rs/month

☐ 8 hrs/day ☐ 6 hrs/day ☐ 4 hrs/day ☐ 2 hrs/day ☐ other.....

3. How has the MHP made difference in you day-to-day activities?

4. How many times over the year has the MHP been shut down for repair and maintenance? How long was it shut down for? How was it fixed?

5. Does the local operator fixes the problem or experts from outside are called to fix the problem?

6. What are the minor and major complaints you have about the MHP?

7. Do you think MHP is a better option then electricity from the national grid? Why/Why not?

8. When the MHP was established, did it effect nearby fishermen or farmers? Was there any change in the natural surrounding?

Appendix B: Open-ended interview questionnaire (Project Promoters/Managers)

PP1. When was the MHP established?

PP2. What is the power output of the MHP?

PP3. What was the main purpose of establishing the MHP? Is the MHP working according to its goals?

PP4. What were the funding sources for the MHP? Does it have any outstanding loans?

PP4. Has the MHP made any profit? What was the payback period established for the MHP?

PP6. How many households does the MHP serve currently? Does it provides services to schools, hotels or any other commercial facilities? Are there any projects in the pipeline to extend the services to the entire village?

PP7. Was there any permits involved during the establishment of the MHP? Is there any regulation that the MHP must follow?

PP8. Was the community consulted before establishing the project? If yes, what was the response?

PP9. How far is the national grid from the village? What will happen to the MHP if the national grid is extended to the village?

PP10. What is the management protocol of the MHP? Are the managers/operators are hired locally or not? What are the key responsibilities of these managers?

PP11. Does the MHP provide energy for both domestic and industrial purposes?

PP12. Are there any local committees established to look after the MHP? How does these communities function? Do they form community meetings? How are the villagers mobilized to participate?

PP13. Do members from all ethnic group participate in the meetings? Has there been any incident or differences between ethnic groups because of the race?

Appendix C: Focus group discussion agenda

The focus group will be a free flowing conversation between the participants. However, agenda will be designed to guide the discussion. Below is an initial draft of the agenda, which will be modified after the interviews and surveys.

1. What do you think about the Micro-hydro project in your VDC?
2. Do you know it is a community-based MHP? If yes, what does that mean.
3. Do you think participation matters?
4. What is your definition of participation?
5. Do you the services provided by the MHP is reliable and fair to all the population?
6. Why are male/female more involved or less involved with the MHP?
7. Do you the MHP should be expand its services to the entire village?